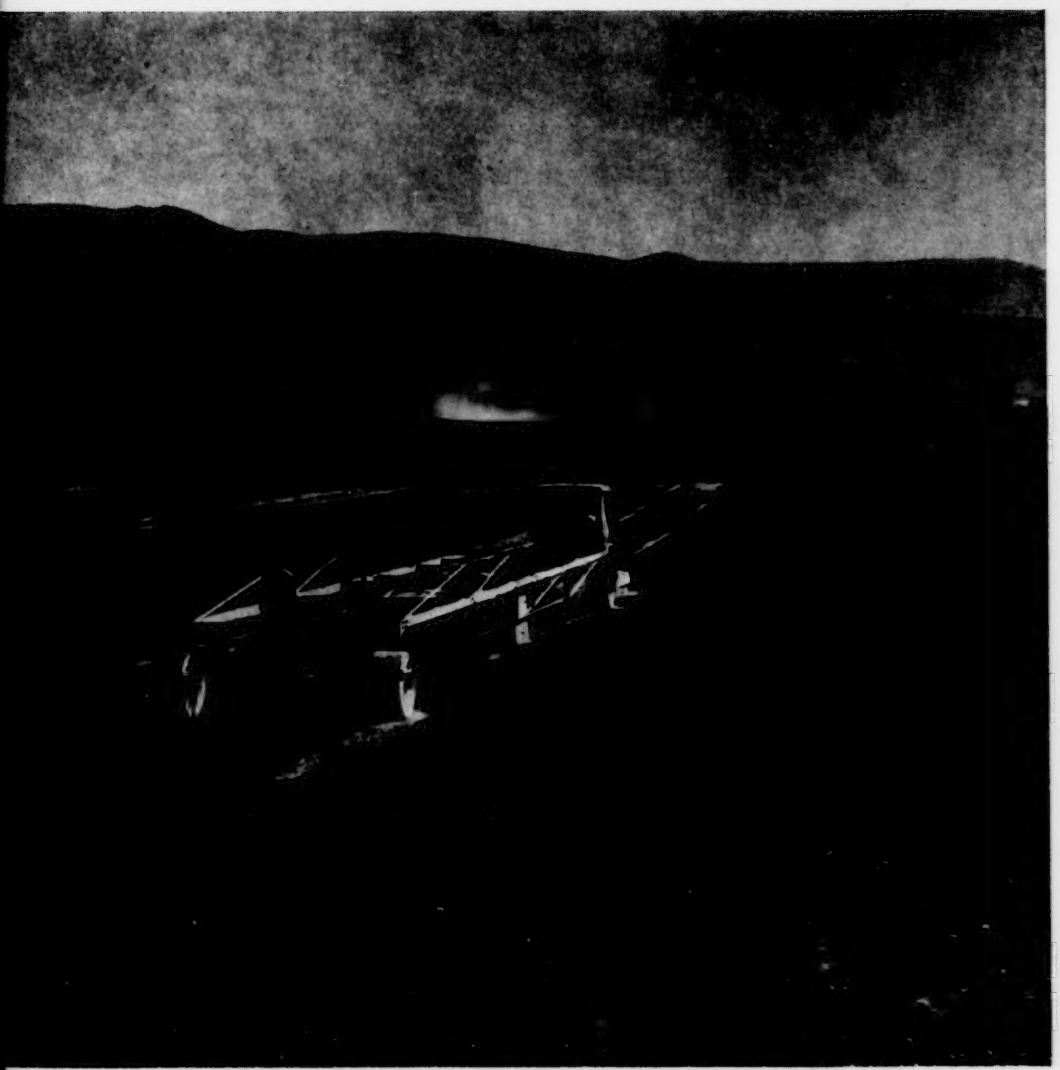


Volume 16, No. 2
March-April
1961

Aspects of Conservation

Evaporation from Agricultural Lands

Alternate-Row Grass-Legume Seeding

Mississippi Delta Land Drainage

Land Leveling and Soil Fertility

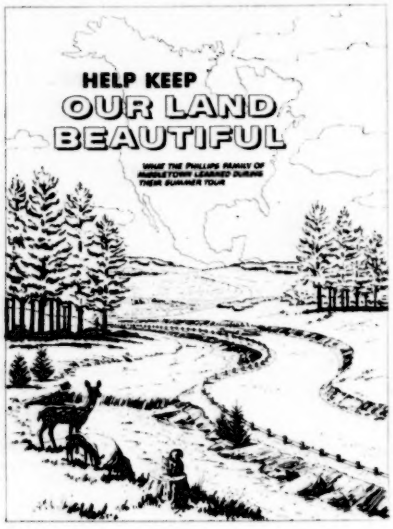
Weed Control in Farm Ponds

Use and Returns from Reservoir Areas

Architect's Sketch of the Permanent Home for the Society

(See the center insert)

SCSA Presents



Fifth in a series of popular type booklets with a conservation message for young and old alike is the Society's newest four color publication —Help Keep Our Land Beautiful.

Developed by a Society committee, the booklet is the story of a typical American family on a summer vacation trip in their station wagon. They are concerned about natural resources and make many observations on the mythical trip—urban and industrial development on agricultural land, littered camp sites, polluted streams, soil erosion, flooding, dust storms, burned forests, over-grazed ranges, and practices that destroy wildlife.

But the family is studious and at each observation they try to determine what could and should be done for the resource involved.

They visit with sportsmen and leaders of industry to learn of efforts in pollution control and improved wildlife practices. The family visits with farmers and ranchers, and with professional conservationists interested in soil, water, forests, and wildlife. They visit with public officials, including the Governor.

One of the highlights is a visit to a local soil conservation district. Finally they make an air trip to see the beautiful countryside made that way by intelligent land use practices.

The general conclusion of the booklet is that America will not only

(Continued on page 96)

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TO ADVANCE THE SCIENCE AND ART OF GOOD LAND USE

JOURNAL OF SOIL AND WATER CONSERVATION®

March-April 1961 Volume 16 Number 2

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COVER: A 60 foot landplane levels land in preparation for irrigation prior to planting. See article on page 71.

Soil Conservation Service Photo

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says Harlan Smith, Smith Brothers Engineering & Leveling Co., Kearney, Nebraska, soil conservation contracting specialists.

Smith Brothers use five Allis-Chalmers TS-260's to handle a multitude of scattered soil conservation jobs ranging in size from 1,000 to 70,000 yds. Here's why this company believes Allis-Chalmers all-hydraulic motor scrapers can't be beat on fast-moving operations.

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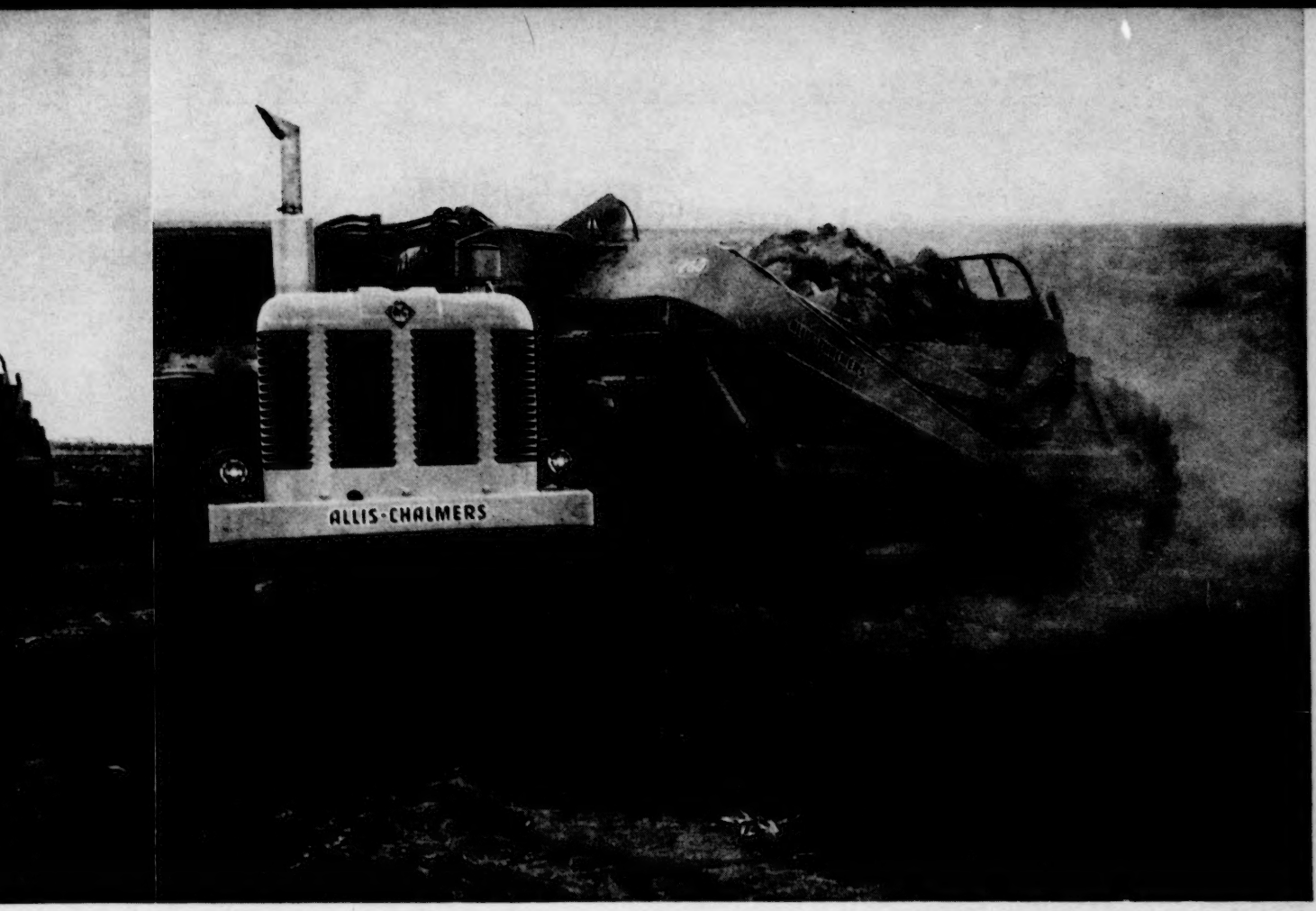

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"TO ADVANCE THE SCIENCE AND ART OF GOOD LAND USE"

838 Fifth Avenue — Telephone CHerry 4-4833 — Des Moines 14, Iowa

Dear Fellow Conservationists:

In this issue of the Journal is a detailed account of the Society's plans and aspirations pertaining to the construction of a headquarters building. I urge you to become familiar with this great undertaking for it represents an important milestone in our short period of existence.

Also significant is the fact that the building will be dedicated in memory of the late Hugh Hammond Bennett, "Father of Soil Conservation" and founder of the Soil Conservation Society of America. It was his vision and crusading zeal that gave America and the world a new land use concept, which touched the lives and future of uncounted millions. His writings and mementos will be housed in the Society's extensive library, thereby keeping before us the achievements and hopes of this great man.

Our plans are firm, including the matter of raising $100,000 to finance the construction of the building late in 1961. Of this amount, $22,998.00 has already been contributed. This leaves approximately $40,000.00 to be raised during the next few months in order to meet the goal of 60 percent cash on hand prior to beginning construction.

I have every reason to believe that this goal will be met in ample time. The Society's Building Fund Committee, under whose direction the funds are being solicited, has performed well. It will continue to work with chapters and national leaders to complete its assignment; however, its success depends upon the response of the membership. Let us then go all out by making, if you have not already done so, a substantial pledge now. This can be done either through your local chapter or direct to our national headquarters.

As a closing reminder I implore each of you to do three things:

1. Read the Society headquarters building story on the center insert and on page 91 of this issue of the Journal.

2. Make or complete your pledge to the building fund now. A handy form will be found on page 90.

3. Enlist the financial support of persons other than Society members. By so doing, you will be playing a significant role in this important undertaking.

Sincerely yours,

Walter C. Gumbel

March 6, 1961

Walter C. Gumbel
President

Aspects of Conservation—
Political, Social, Economic

—A. ALLAN SCHMID

WHAT DOES CONSERVATION MEAN? Almost everyone is for it, and the term is used to justify nearly everything from the stabilization of petroleum prices to the preservation of the whooping crane. For example, one "conservationist" will say that a dam should be constructed on a certain stream to provide more frontage for cottages and more water surface area for boating, while another says the stream should be left in a natural state and stocked with trout. Still another "conservationist" thinks the rate of pumping oil should be adjusted so that the known supply will last a given number of years, while his colleague says oil should be pumped as fast as it is needed, and by the time today's known supplies run out, new supplies or substitutes will be found.

How can problems like this be analyzed? Merely being *for* conservation obviously will not help. To evaluate conservation alternatives the economic, political, and social facets must be examined.

Economic Aspects of Conservation

Proper Rate of Use

One of the central problems of conservation is the proper rate of use of a resource. In the case of renewable resources it is common to speak of sustained yield. This means that the rate of use is such that the productivity of the resource is constant over time. But what is meant by productivity? Some regard conservation as maintaining the resource intact from some given point in time. In the case of soil conservation, the prevention of all erosion is physically difficult even if man did not disturb the soil. It is important to distinguish between physical erosion and soil fertility for they may or may not be interrelated. Fertility can be improved despite a certain degree of physical erosion.

A. Allan Schmid is assistant professor in the Department of Agricultural Economics at Michigan State University, East Lansing.

Physical vs. Value Productivity

The maintenance of the soil's ability to produce a given physical product, such as a bushel of corn, is different from its ability to produce a given value product, such as a dollar's worth of corn. The amount of money that can be invested in soil productivity maintenance depends on the future value of the product, and this is always uncertain. The two components of value productivity are physical productivity and price. Both change over time. First, the price of a product is a function of supply and demand. Demand is influenced by changes in consumer preferences and availability of substitute products. Second, physical product output does not depend entirely on the productivity of the land, but also on the skill with which other factors of production are applied. Thus, the cost of producing a given physical product varies over time with the level of technology and human skill. The upward trend in the production of agricultural products at the same time that the amount of harvested cropland has not increased shows that other productive factors have been substituted for land.

The contribution to physical production of an expenditure for conservation, such as erosion control, must be compared with the cost and contribution of other productive inputs, such as fertilizer. The maintenance of the physical productivity of a resource at a given level independent of the input costs and product prices may be economically unsound.

Both the concepts of physical and value productivity are useful, but we should be aware of the problems involved. The problems of complexity and uncertainty in using the concept of value productivity cannot be avoided. The consideration of value puts the emphasis on people, their motives and needs. A resource is not even a resource unless man discovers a use for it. For example, until recently, uranium was just another material in the ground and no one was concerned with its preservation or rate of use.

Concern for the Future

Concern for the future is central to the concept of conservation. Pleas to preserve a birthright for future generations provide conservation with much of its emotional appeal. Care must be taken when speaking of conservation in the abstract because it is not possible to preserve nor reduce the rate of use of all resources unless people are removed from the face of the earth or their

standard of living is substantially reduced. Usually, what one is really talking about is affecting the use of a particular resource, and this normally means increasing the use of a substitute resource—assuming, of course, that the possibilities for the prevention of waste have been exhausted. Investment in preservation or development means less of other goods in the future. Conservation can only change the composition of future goods and materials.

Conservation of a non-renewable resource such as coal will increase the rate of use of other resources such as oil, unless one wishes to do without locomotion. When making an appeal for reduction of the rate of use of a resource care must be taken to examine the possibility of an increase in the price of the resource as a result. This increased cost may be borne by a different group than that which wants and benefits from the conservation. To illustrate, suppose a piece of lake shore property which is presently a wildlife area is desired by a factory which needs to be near water. If the factory must be built away from the water the increased costs will be borne by the consumers of the plant's product, not by those who consume the products of the land used for wildlife. The point here is that the question of who pays for conservation is an important one. This is also illustrated by history. The eastern United States reached maturity first and favored conservation before the West was ready for the West wanted to exploit its natural resources to attract population and encourage economic development.

Discounting Future Values

Another problem in evaluating conservation which decreases present use and increases the future rate of use of a resource is the fact that future value must be discounted. Most people would prefer to have a $100 return from a particular resource today rather than to wait a year for it. However, people would wait if they thought they could get more than the $100—say an extra 5 percent. How much more depends on the preference for present income over future income. The extra future return needed to make one indifferent as between present and future income is called the discount rate. The more the present value of future profits are discounted the less conservation can be practiced. A rich person and a rich economy are likely to practice more conservation than a poor nation because the rich will discount future profits less since they have enough income to meet present consumption needs.

Uncertainty also affects the extent to which future income is discounted. In addition to the effects of price uncertainty, there is the uncertainty arising out of the relationships between people. For example, a tenant farmer is uncertain that his conservation investment will be recovered if he is forced to move.

The Role of Technology

An additional factor contributing to uncertainty is the role of technology. A new technology can increase the supply of a given resource and thereby lower its price. Technology may also affect the price of a given resource by affecting the productivity of substitute resources. Technology thus makes the problem of the proper rate of use difficult. To speak of reserves of resources in barrels or tons ignores the possibility of technological change. Note the decreasing importance of coal as mining methods increased production and large users such as trains switched to superior substitutes. Some feel that conservation is not necessary because necessity is the mother of invention, and if a particular resource is exhausted man will develop a substitute for it, but others don't want to take the chance.

Evaluating Conservation Issues

What sort of analytical criteria can be used to evaluate conservation issues if so many facets are uncertain? In the case of renewable resources one possible suggestion is to establish a safe minimum standard for important resources. This minimum standard can be stated in terms of use or depletion up to the point where it would be physically impossible to bring renewable resources back up to a higher level of productivity. This varies for different resources, but it is known that after soil erosion has reached a certain point the land cannot be restored, or if birds or fish are taken in a certain way the species can be destroyed.

In the case of non-renewable resources such as oil, investment in conservation and reduction in present rates of use to insure a future supply may be regarded as an investment in an insurance policy. The costs of conservation can be considered as an insurance premium in case new technology and substitutes do not come through.

The future rate of use of a particular renewable resource can be increased merely by decreasing the present rate of use or by investment in development. Over time, a nation may want to use resources faster than they can naturally replace themselves and at other times investments may be made which improve on the rate of natural replacement. Forest production is an example. At times, trees are cut faster than the replacement growth rate and at other times new trees are planted to aid nature. A sustained yield of forests does not allow for changing needs. The clean cutting of pine in the Lake States is usually regarded as an extreme example of poor conservation. Clean cutting without regard for reseeding certainly violates the concept of a safe minimum standard. However, there are times when a nation may want to use a resource faster than it can replace itself. The forest products of the Lake States contributed to the economic development of Chicago and the Midwest. If this lumber

had not been available it would be difficult to imagine the effect on the economic growth of the treeless plains. Even with present hindsight it would be a tough policy decision to weigh the needs for housing materials in the 1800's with today's forest uses, assuming that agreement could be reached on the prevention of waste and provision for reseeding.

Such a policy decision brings parties and considerations other than merely the loggers into the picture. The loggers were faced with only the demand for lumber on the one hand and the costs of extraction, transportation, and payments to the owners of the land on the other. The price-cost relationship was such that the rate of use was very rapid and did not take into account the interests of various other people including future generations. Examples abound where the costs were low and a resource was rapidly destroyed. A case in point is that of the snowy egret. The billowy feathers of this bird were much in demand as decorations on grandmother's hat and this bird's beauty almost led to its extinction at the turn of the century. The fact that some interests such as bird lovers were not effectively represented in the rate of use decisions led to the formation of the Audubon Society. This organization got a Federal law passed to protect most nongame birds in 1918.

SCS Photo

Adequate procedures to compromise equitably the conflict of interests concerned with land use will lead to better resource-use planning.

Political and Social Aspects of Conservation

Conservation problems are more than future versus present or the result of mere selfishness or stupidity on the part of some people. There is the very legitimate problem of conflicting interests. The problem of our political and social system is how these people can reach agreements so that they can live together. Conservation problems would certainly be easier if we could ignore people and worry only about physical relationships. If all people had the same interests we would need no conservation policy nor political procedures for discussion and compromise.

If conflicts of interest are not settled satisfactorily by the market, the problem is usually settled by the political system. What kinds of guides can be found to evaluate the operation of this system? The common answer is that conflicts should be settled in the public interest. But what is the public interest? Can the concept of the public interest be used as a measuring stick? Some regard conservation and the public interest as synonomous, but it has been demonstrated that what is conservation for one party is detrimental to the interests of another.

Public Versus Private Interests

The use of a resource involves a transaction between two parties directly involved—usually a buyer and seller. In the case of egret feathers, the person who collected the feathers and made the hats was engaged in a transaction with grandmother who bought the hats. However, others interested in egrets such as the birdwatchers were not directly involved in the transaction, and thus the Audubon Society was formed in order to further the interests of third parties not directly involved in this resource use. For discussion here, such a society may be regarded as a public. A public consists of those who are affected by the indirect consequences of resource use transactions to a degree that they find it necessary to attempt to control these consequences in a systematic way.

The above definition of a public, like all definitions, gives a method of classification of different groups. It does not give a criterion in itself for stating what is a good or right action. The private interest is defined as the parties directly involved in a transaction and the public as those third parties indirectly involved. This distinction is not equivalent to the distinction between in-

dividual and social. Many private acts are social and have beneficial consequences for the public. The conduct of private business provides the public with many beneficial goods and services even if the intent of the business is strictly private profit. The line that is usually drawn between private and public cannot simply be used to indicate the desirable course of action. The question is not what is a public interest over against a private interest, but is the interest or use merely a private interest or does it also contain public benefit?

The problem is further complicated by the fact that the interests of third parties are not always the same. There are many publics. In any conservation question there may be several distinct groups which are indirectly affected by a private transaction, but their interests may be conflicting.

Settling Conservation Conflicts

Conservation conflicts are not easily settled even by an appeal to the numbers of people involved in each use. Take the experience of camping or walking through a wilderness area. The very nature of the experience means that use of the area must be restricted or the mere number of people will ruin the quality of the experience for all. Still it can be argued that a better use of the area would be to build roads, picnic areas, and concessions so that a larger number of people could use the land. Such complicated conservation problems are going to face us more frequently as our population and leisure time grow.

The existence of a conflict of interest means that the parties are interdependent. One person's use affects another's use. Recognition of this fact is the first step toward compromise of these interests. Lack of conflict compromise among the parties often results in a situation that is unfavorable to all. In the extreme instance it takes the form of open aggression such as when fishermen fear the effect of irrigation withdrawals and put sand in the irrigators' pumps. In a milder form it may mean a lack of security which may lead to poor planning and even waste and quick exploitation. If all groups recognize that they are in the same boat they will be more willing to hammer out agreements. These agreements cannot give each party all it wants but each has a common interest in formulating a solution that will make it possible for them to live together. One point that should be kept in mind when disputes over how the pie is to be sliced arise is that there may be ways in which the size of the pie can be increased for all through investment, development, and management.

Society derives benefits from the use of resources by those directly involved in a transaction and by a wide variety of third parties. The solution to conflicts of interest between these groups is a procedure which allows all parties to be represented in the decision. It is the task of a democratic system of government to see to it that all interests are represented.

One cannot assume that third parties affected indirectly by a resource use transaction will automatically be able to form a political action group so that their interests will bear on the use. The task of organizing these publics is a difficult one since the individual members may be widely spread geographically and not recognize a common interest. Also, the effects of a resource use transaction may be small on the individual so that it is not worth his while to attempt to control it. Still the aggregate effect may be considerable especially if it should affect the rate of growth of a community. One of the big problems for effective political action is that the difficulty must not only be felt and suffered but its cause and origin must be identified before action can be taken to control it.

A Positive Suggestion

One positive suggestion that can be made at this point is that we need to analyze the procedures available for the representation of all parties with respect to particular resource use problems. One of the procedures often used is the public hearing at which all interested parties may appear to present their case. For example, the State of Michigan has a procedure for setting the minimum levels of inland lakes. The problem is one of stabilizing the level of the lake, but conflicts can arise between property owners on high and low ground. The law provides that after a petition is submitted the circuit court holds a public hearing. The law also provides that the State Conservation Department may conduct detailed investigations of the effects of lake levels on various interests. This provision of expert investigation supplements the information gained in the public hearing and should mean that the interests of those directly and indirectly concerned are brought to bear on the lake level decision.

In conclusion, two conservation policy guides can be stated.

1. The public must make certain *directional policy* decisions. This includes the concept of a minimum safe standard to prevent a rate of use beyond a point where a renewable resource cannot be restored to a greater level of productivity. It means that decisions should be made to point resource use in the right direction. It provides bounds to action so that results are more predictable and uncertainty is recognized, rather than establishing a precise set of priority of use.

2. There must be *adequate procedures* so that the interests of the public (third parties) will be represented. Emphasis in developing procedures should be on facilitating compromise and agreement between conflicting parties.

Evaporation From Agricultural Lands

J. S. ROBINS

Inadequate water supplies that limit production on most of the 200 million acres of cropland, the 600 million acres of rangeland, and much of the forested area are definitely a vital problem in the Western States. As municipal and industrial water use increases, supplies for agriculture and forestry will become more limited.

LACK OF CONSISTENT moisture supplies also contributes materially to the wind erosion problem through the necessity of summer fallowing and through inconsistent production of crop residues to protect the land. Effective utilization of range vegetation is often difficult due to lack of stock water supplies. Potential and presently developed irrigation projects are more often limited by insufficient water supplies than by inadequate suitable land. As population pressures increase, towns and cities find water supply their most pressing problem.

Total precipitation in the 17 Western States has been estimated at between 12 and 13 inches annually (8). This represents between 1.2 and 1.3 billion acre-feet total water supply. Runoff ranges from less than one-fourth inch annually in desert areas to more than 80 inches in the Olympic Mountains in Washington (10, 11). Over half of the total area produces less than 1 inch of runoff annually and over 30 percent contributes between 1 and 10 inches. Runoff exceeding 10 inches annually generally is restricted to higher elevations of the central and northern Rockies, the Cascade and Coastal ranges of western Washington and Oregon and northern California, and the Sierras in California. Runoff from crop and range land generally is 1 to 5 inches annually.

That water which does not run off either: (1) evaporates from soil, snow or plant surfaces; or (2) infiltrates into the soil and is transpired back to the atmosphere by vegetation, or percolated to the ground water supply.

Evaporation from Summer Fallowed Land

The 1954 Agricultural Census reports that in excess of 28 million cropland acres are normally summer fallowed in the 17 Western States. The Great Plains, the Pacific Northwest wheat area, and California contribute a high percentage of the total.

Inefficiency of the fallow system in storage of precipitation is well documented. For example, Thysell reports for the period 1914 to 1934 in spring wheat production at Mandan, North Dakota, an average storage of 20 percent of precipitation received (15). Average water stored for the fallow year (12 months ending with seeding of the crop) was 2.2 inches of the 15.4 inches precipitation or less than 14 percent. Similar percentages have been noted throughout the Great Plains (12).

In the Pacific Northwest area where winter precipitation dominates, net losses of stored moisture are common during the summer prior to planting winter wheat. For spring wheat, second winter storage is usually less than 20 percent of precipitation.

A portion of the water loss during the noncrop season is due to runoff and an additional amount to weed and volunteer crop growth. Since fallowing is normally practiced in areas of less than 15 inches precipitation, runoff losses are usually low. Measurements and estimates indicate such losses at 5 to 15 percent of precipitation on fallow land (16). Weeds and volunteer crop growth consume appreciable quantities of water on fallow land. However, results of tillage intensity studies indicate that water lost to weeds or volunteer crop growth on poorly managed fallow is lost by added evaporation when such growth is controlled (9). Losses of water by deep percolation on fallow are extremely limited (4).

The remaining losses on fallow are the result of evaporation from the soil surface. Assuming a conservative estimate of 14 inches annual precipitation on the 28 million fallow acres and a seasonal loss of 70 percent of this precipitation, the annual loss by evaporation would be about 23 million acre-feet of water. Although this represents only about 2 percent of the West's total water supply, its elimination would have far-reaching implications.

Research results indicate that wheat yield per acre per inch of water consumed ranges from 2 to 5 bushels (1, 2). For sorghum, production per acre per inch ranges from about 3 to as much as 8 bushels (3, 16). For fertilized grass and for sorghum or corn forage, production per acre per inch usually ranges from 100 to 400 pounds of dry matter (3, 14).

If only that water presently evaporated from fallowed land during the fallow year could be effectively utilized

J. S. Robins is soil scientist with the Western Soil and Water Management Research Branch, Soil and Water Conservation Research Division of the Agricultural Research Service. His headquarters are at Fort Collins, Colorado.

TABLE 1
Effect of Partial and Complete Evaporation Control and Water-use Efficiency.

Location and crop	*Treatment*	*Water Use*	*Yield*[1]	*Water use efficiency*[1]
		Inches	*Lbs./acre*	*Lbs./inch*
Mandan, N. Dak.[2] (Corn)	Bare	10.4	2730	262
	Bare with irrigation	16.8	4340	258
	Partial cover	10.7	3020	282
	Partial cover with irrigation	15.6	5360	343
	Complete cover	4.6	2610	568
	Complete cover with irrigation	12.2	4840	397
Bozeman, Montana[3] (Corn)	Bare	12.3	6060	493
	Bare with irrigation	15.2	6300	414
	Partial cover	11.6	7260	626
	Partial cover with irrigation	12.6	6360	505
	Complete cover	7.0	5640	806
	Complete cover with irrigation	9.6	6540	681
North Platte, Nebraska[4] (Sorghum)	Bare	14.4	3640	253
	Partial cover	15.1	4200	278
	Complete cover	5.3	4370	822
(Corn)	Bare	13.5	3700	274
	Partial cover	13.7	3750	274
	Complete cover	6.2	3530	571
Akron, Colorado[5] (Sorghum)	Bare	11.2	2640	236
	Bare with irrigation	12.8	3400	266
	Partial cover	11.3	5040	446
	Partial cover with irrigation	12.2	5400	444
	Complete cover	6.4	3840	600
	Complete cover with irrigation	7.9	4560	577
Bushland Texas[6] (Sorghum)	Bare	10.5	5270	502
	Bare with irrigation	19.6	6660	340
	Partial cover	10.6	6310	595
	Partial cover with irrigation	16.9	9050	536
	Complete cover	7.6	5960	784
Big Spring, Texas[7] (Sorghum)	Bare	7.6	2870	378
	Bare with irrigation	9.8	4690	478
	Partial cover	7.6	3420	450
	Partial cover with irrigation	10.8	4820	446
	Complete cover	2.5	2710	1080
	Complete cover with irrigation	5.1	4040	793

[1] Yields and efficiencies at North Platte, Nebraska, and Big Spring, Texas, based on grain only; all others based on total dry matter.
[2] Seasonal rainfall (May 27 to September 12) was 7.4 inches. Irrigations totaled 9.3 inches on bare and partial cover treatments, and 12.8 inches under complete cover.
[3] Seasonal rainfall (May 21 to September 17) was 6.6 inches. Irrigation totaled 7.2 inches on bare treatment and 4.8 inches on partial and complete cover treatments.
[4] No irrigation required due to above-normal precipitation (July 2 to December 2) was 10.48 inches. Corn yields low due to late planting of short season variety.
[5] Seasonal rainfall (July 1 to October 12) was 4.9 inches. Irrigations totaled 2.0 inches on irrigated plots.
[6] Seasonal precipitation (July 14 to November 4) was 10.5 inches. Irrigations totaled 10.1 inches on bare treatment and 9.1 inches on partial cover treatment.
[7] Seasonal precipitation (July 16 to September 30) was 4.1 inches. Irrigations totaled 5 inches on irrigated treatments. Two inches supplemental water was added to "unirrigated" treatments to assure germination and crop establishment.

by a crop, gross returns under present management would be in excess of 20 bushels per acre of wheat, 30 bushels per acre of sorghum, or 1,000 pounds per acre of grass, sorghum or corn forage dry matter.

It may appear inconceivable to completely eliminate this loss. However, as pointed out by Haas and Boatwright (5) a reasonable increase in the efficiency of storage between crops in a continuous system, through evaporation control or other means could completely eliminate the necessity for fallowing. This would not only yield a great water economy but in effect would add an equivalent acreage to the nation's cropland through annual cropping in lieu of alternate crop and fallow.

Evaporation from Cropped Lands

Recent information indicates that evaporation in row crops may account for up to 50 percent of total growing season evapotranspiration (6, 13). In recent work at several locations in the Great Plains by the staff of the Western Soil and Water Management Research Branch, Soil and Water Conservation Research Division, Agricultural Research Service,[1] evaporation was controlled by covering all or part of the soil surface with plastic film. Data in table generally confirm previous results and show the greatly increased yield per inch of water used where evaporation was completely or partially controlled.

The most significant feature of this data perhaps is the small amount of water required for good plant growth. Control of water loss exercised by the plant is remarkable. Water use during the cropping period in the absence of evaporation varied in these experiments from 2.5 to 12.2 inches. Where abundant water was available at Mandan and Bozeman, use was 12.2 and 9.6 inches, respectively. Thus, if losses by evaporation and weed growth during the growing season could be reduced to a reasonable level, high yields could be obtained on annually cropped land in areas where precipitation is 15 inches or less annually. At present, production is hazardous even in areas of 15 to 20 inches annual precipitation.

The above data have similar implications for irrigated lands. Partial or complete evaporation control could greatly reduce irrigation requirements. This would make irrigation water available for added acreage or other purposes as well as reduce labor and water costs.

On the basis of these data, an assump-

[1] Data supplied by H. J. Haas, Mandan, North Dakota; P. L. Brown, Bozeman, Montana; R. E. Ramig, North Platte, Nebraska; B. W. Greb, Akron, Colorado; Earl Burnet, Big Spring, Texas; and V. L. Hauser, Bushland, Texas.

tion that 50 percent of the annual evapotranspiration is lost from cropped acreage should be conservative considering the high losses incurred from irrigated lands and the losses during the interval between crops. Assuming an average of 15 inches annual evapotranspiration, evaporation losses would amount to about 100 million acre-feet on the 170 million cropped acres (exclusive of summer fallowed land) in the 17 Western States. This total nearly equals combined use for irrigation, municipal, industrial and domestic purposes in these States. The water saved, if appreciable reductions in these losses could be effected, would be sufficient to produce near maximum yields on nonirrigated cropped land and, in many cases, provide an excess for addition to surface or subsurface supplies.

Present methods and materials for such control are not feasible except for certain specialty crops or where water is in extremely short supply and thus expensive. However, as cheaper materials or simpler, more effective procedures are developed, their application could effect a major water saving and improve utilization of existing supplies. Present and potential water shortages lend ever-increasing emphasis to the need for such control methods.

Evaporation from Range and Forested Lands

Physical information to estimate surface evaporation losses from range or forested and essentially nonvegetated (desert and alpine) lands is largely lacking. Grasses which provide complete cover should considerably reduce evaporation from the soil surface as compared to cultivated crops. However, in western range areas, such cover is seldom attained due to sparse vegetative growth or the low growth habit of much of the vegetation. In addition, either natural or drought-induced dormancy occurs for extended periods on large acreages. Forested or brush-covered lands similarly do not provide complete cover. Neither beneficial plants nor effective cover occur on major western land areas. Thus, evaporation from the soil surface is undoubtedly a serious source of water loss from range, forested and nonvegetated lands.

In view of the acreages involved (600 million rangeland, 250 million forested and 100 million desert and alpine) evaporative losses from such lands probably greatly exceed those from fallow and cropped land combined.

Control of these evaporative losses on rangelands undoubtedly would increase forage production as well as provide more consistent and adequate vegetative cover for land protection. In forested or watershed areas, evaporation control would increase tree growth as well as water yield. In addition, the improved moisture regime would permit application of more intensive soil and plant management practices to improve efficiency of water use. It is ironic indeed that inadequate moisture supplies, resulting in part at least from evaporation and other water losses, contribute so greatly to inefficient use of the water consumed by economic plants.

Recent data indicate that evaporation of moisture from the soil in row crops, such as the sorghum shown on the left, accounts for 40 to 60 percent of the total growing season evapotranspiration. Losses are probably of similar magnitude from close growing crops such as the wheat on the right.

Possibilities for Evaporation Control

The previous analysis indicates that evaporation from soil, plant and water surfaces in the West consumes a very significant portion of the total precipitation. Allowing 30 percent as contributing to fresh water supplies, either by direct runoff or through deep penetration, leaves about 70 percent presumably used in evapotranspiration. It appears that evaporation from soil, water, snow and plant surfaces probably accounts for nearly 50 percent of this total or about 35 percent of total precipitation in the West.

A major portion of this loss occurs from lands with vegetative cover although losses from water surfaces are likewise significant. Even partial evaporation control procedures applied to vegetated or fallow lands would provide major benefits through stabilizing production and improving efficiency of water utilization. Such an increase and stabilization of moisture supplies would permit application of more intensive soil and plant management practices and consequently major improvement in farming and ranching efficiency. In addition, fresh water supplies for irrigation or other uses would undoubtedly be increased by control of evaporation.

Two general possibilities for control of evaporation from soils then appear. The first possibility is chemical, mechanical or other direct treatment of soil, plant or water surfaces to reduce or prevent evaporation by controlling moisture flow or moisture exchange with the atmosphere. Hide (7) has discussed certain aspects of this problem for soil moisture evaporation. Included in this area are plastic or other mechanical barriers, chemical or physical treatment of soil layers to control liquid or vapor flow to the soil surface and physical or chemical control of the depth in the soil at which water is stored.

The second possibility is that of water concentration, i.e., collection of part or nearly all the precipitation from parts of the land area and use of this water to "irrigate" the remainder or for other purposes. Such procedures would reduce the evaporative surface and permit more continuous and efficient crop production. This postulates sealing and stabilizing water collection areas and development of collection, transport and distribution facilities. Application of intensive management to areas where water is applied would necessarily follow. Such a procedure would have greatest application in areas where large amounts of land, topographically or with soils unsuited to cultivation exist. Such areas are abundant throughout the West.

Water Use Efficiency

Water presently consumed by economic plants can be considered beneficial use even though present utilization is often extremely inefficient. In many cases, production per unit of water could be vastly improved through proper fertilization, weed control, plant population or other cultural or management treatment. However, added moisture for transpiration would probably do more to stabilize production than any other single factor. With an increased and stabilized supply, more intensive management and culture could be applied with vast improvement in efficiency of production and water utilization. Control of evaporation from soil surfaces appears to be the most feasible mechanism to this end.

With present and impending water shortages throughout the West, and the gross inefficiency in utilization of present supplies, added attention must be directed toward the many aspects of this problem. Although major improvements could be effected through more adequate management on both irrigated and nonirrigated lands, long-range solution of the West's water problem could be most effectively implemented by development of practical and economic evaporation control procedures.

REFERENCES CITED

1. Army, T. J., and W. D. Hanson. Accepted for publication. *Weather and spring wheat production in the Plains area of Montana.* U.S. Dept. Agr. Prod. Res. Rept. Washington, D.C.
2. Army, T. J., J. J. Bond, and C. E. Van Doren Accepted for publication. *Precipitation-yield relationships in dryland wheat production on medium- to fine-textured soils of the southern Great Plains.* Agron. Jour.
3. Brown, Paul L., and W. D. Shrader. 1959. *Grain yields, evapotranspiration and water use efficiency of grain sorghum under different cultural practices.* Agron. Jour. 51 (6): 339-343. June.
4. Cole, J. S., and O. R. Mathews. 1939. *Subsoil moisture under semiarid conditions.* U.S. Dept. Agr. Tech. Bul. 637. Washington, D.C. 77 pp. April.
5. Haas, H. J., and G. O. Boatwright. 1960. *Let's take another look at summer fallow.* Jour. Soil & Water Cons. 15(4): 176-179. July.
6. Harold, L. L., et al. 1959. *Transpiration evaluation of corn grown on a plastic covered lysimeter.* Soil Sci. Soc. Am. Proc. 23 (2): 174-178. March-April.
7. Hide, J. C. 1954. *Observations on factors influencing the evaporation of soil moisture.* Soil Sci. Soc. Am. Proc. 18 (3): 234-239. July.
8. Kohler, Karl. O. Jr. 1955. *Trends in the utilization of water.* U.S. Dept. Agr. Yearbook. Washington. D.C. pp. 35-40.
9. Kuska, J. B., and O. R. Mathews. 1956. *Dryland crop rotation and tillage experiments at the Colby (Kans.) Branch Experiment Station.* U.S. Dept. Agr. Circ. 979. Washington, D.C. 87 pp. June.
10. Longheim, Walter B., and J. V. B. Wells. 1955. *The water in rivers and creeks.* U.S. Dept. Agr. Yearbook. Washington, D.C. pp. 52-62.
11. Longheim, Walter B., et al. 1949. *Annual runoff in the United States.* U. S. Geo. Survey Circ. 52. Washington, D.C. 14 pp. June.
12. Mathews, O. R., and T. J. Army. Accepted for publication. *Moisture storage on fallowed wheatland in the Great Plains.* Agron. Jour.
13. Russell, M. B., and R. E. Danielson. 1956. *Time and depth pattern of water use by corn.* Agron. Jour. 48 (4): 163-165. April.
14. Thomas, J. R., and A. Osenbrug. 1959. *Effect of manure, nitrogen, phosphorus and climatic factors on the production and quality of bromegrass-crested wheatgrass hay.* Agron. Jour. 51 (2): 63-66. February.
15. Thysell, J. C. 1938. *Conservation and use of soil moisture at Mandan, North Dakota.* U.S. Dept. Agr. Tech. Bul. 617. Washington, D.C. 40 pp. June.
16. Zingg, A. W., and V. L. Hauser. 1959. *Terrace benching to save potential runoff for semiarid land.* Agron. Jour. 51 (5): 289-292. May.

Alternate-Row Grass-Legume Seedings

ROBERT S. MACLAUCHLAN AND A. L. HAFENRICHTER

Alternate-row seedings have been used in grass-legume trial work in the Pacific Northwest for more than 20 years. The salient features of this method are the elimination of competition between the grass and the legume during establishment, and the reduction of competition between them in subsequent years. The alternate-row method is used most extensively in the establishment of mixtures of grass with birdsfoot trefoil (Lotus corniculatus), *alfalfa* (Medicago sativa), *or sweet clover* (Melilotus spp.)

THE FIRST RECORD of the alternate-row technique dates to seedings made in the fall of 1936 and spring of 1937, at Dayton, Washington, and Condon and Moro, Oregon, by V. B. Hawk. He recorded that alternate-row seedings were successful in reducing seedling competition between the legume and grass and thus promoted establishment.[1] In 1938, Hawk established Grimm alfalfa in alternate rows with several grasses at Condon, Oregon. This work was reported by McClure et al. (15). In 1940, Stark et al. (19) seeded mixtures containing two grasses in alternate drill rows to eliminate seedling competition and to facilitate study of each grass in the mixture. Chapin et al. (2) called attention to the advantages of planting grasses and legumes in alternate drill rows to eliminate competition between these two kinds of plants during the seedling stage. Entenmann et al.(4) reported on cultural methods, including alternate rows for establishing grass with sweetclover. Woods et al. (20) used the alternate-row method to study the compatability of a large number of grass-alfalfa mixtures on eroded soil. Uniform establishment was consistently obtained by using this method and reduced competition in subsequent years was reported. McWilliams (16) obtained similar results in the Great Plains. W. E. P. Davis was successful with alternate-row seedings of Reed canarygrass *(Phalaris arundinacea)* and Ladino clover at Agassiz, British Columbia.[2] Kilcher and Heinrichs (12) reported that each of three different grass-alfalfa mixtures were more productive in alternate rows than in mixed rows.

The alternate-row method was first introduced in field-sized plantings on farms in soil conservation districts by the Soil Conservation Service as early as 1946. The successful use of the alternate-row seeding method on a field basis has been reported by Hafenrichter (6, 8) and MacLauchlan (14).

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Alternate-Row and Mixed-Row Seedings

Competition between grasses and legumes in mixed-row seedings in the Pacific Northwest has frequently been severe during establishment. Difference in the seedling vigor of the two kinds of plants and climatic conditions following seeding determine the severity of the competition, both in the coastal and intermountain areas. There is also evidence that strong competition often exists between the grass and legume components in subsequent years.

▶ *Coastal Area*

Most non-irrigated seedings in western Oregon and western Washington are planted in the spring or early fall during cool wet weather. This usually results in dominance of the grass. Dominance of the grass is most pronounced in mixed-row seedings of grass with birdsfoot trefoil and is frequently evident when grass is seeded with alfalfa or white clover. A common practice has been to seed alfalfa or birdsfoot trefoil alone in the spring and to drill the grass into the established legume stand the following fall. This procedure often results in unsatisfactory stands of grass.

Competition between the grass and legume components of mixed-row stands has been a problem even after establishment. Cool and wet weather in the spring stimulates early vigorous grass growth while the legume is relatively inactive. The degree of competition is further intensified when the early spring growth of the grass is stimulated with inorganic nitrogen fertilizers. Grass dominance is particularly pronounced when the legumes suffer from a deficiency of phosphate, potash, boron, or calcium.

[1] Soil Conservation Service, USDA. 1938. Annual Progress Report of the Soil Conservation Service Nurseries. Portland, Oregon.
[2] Soil Conservation Service, USDA, 1958. Technical Note 76. Spokane, Washington.

Figure 1. This perfect 6-year-old stand of Cascade lotus and Akaroa orchardgrass was established by the alternate-row method of seeding on a farm in Thurston County, Washington.

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Generally, grass growth in the spring exceeds pasture needs, and some fields are deferred for silage or hay. This results in the legume being covered with a dense canopy of grass, and competition for light becomes critical in mixed seedings.

Competition is significantly reduced when the legume is seeded in alternate rows with grass. Studies conducted at Bellingham, Washington, by the Soil Conservation Service Nursery showed that after five years there was three times as much Cascade lotus *(Lotus corniculatus)* in an alternate-row lotus and Akaroa orchardgrass *(Dactylis glomerata)* seeding as there was in a mixed-row seeding of these same species. Alternate-row Akaroa orchardgrass and Ladino clover *(Trifolium repens latum)* seedings still contained approximately 50 percent Ladino clover by weight after six years.[3]

Reduced competition resulting from the alternate-row seeding method has been demonstrated in many field-size plantings in soil conservation districts. Stands of Cascade lotus and Akaroa orchardgrass and of alfalfa and Akaroa orchardgrass established by the alternate-row seeding method in 1954 contain about 50 percent of each of the legumes after six years (figure 1).

Intermountain Area

Alternate-row seedings of grass with alfalfa in the intermountain area of the Pacific Northwest favor the grass portion of dryland alfalfa-grass seedings. Woods et al. (20) reported there was strong competition between alfalfa and grass during and following establishment of the mixture in mixed-row seedings. They were successful in maintaining 20 grasses in alternate rows with alfalfa in dryland studies at Pullman, Washington. The mixtures averaged 20 percent grass by weight. Only six of the grasses were able to maintain stands for five years in mixed-row seedings. This is important, since mixtures of grass with alfalfa are more effective in soil and water conservation and bloat prevention than is alfalfa grown alone.

The Soil Conservation Service Plant Materials Center at Aberdeen, Idaho, grew alternate-row seedings of grass and alfalfa under dryland conditions at Tetonia, Idaho. These seedings resulted in greater forage production than either alfalfa or grass alone.[4]

In northern California, a high percentage of the grass and alfalfa seedings are now planted in alternate rows.

Methods of Seeding in Alternate Rows

Grain drills with a six- or seven-inch disk spacing are recommended in the coast area of the Pacific Northwest, where there is ample moisture and where weed invasion may be a serious problem in more widely spaced rows. In areas where moisture is limited, alternate twelve-inch rows have been successful. Drills with double-disk furrow openers have been most satisfactory.

Drills equipped with small seed attachments are easily modified to seed in alternate rows. Every other feed cup is covered in the grain box and the alternating feed openings are covered in the small seed box. Many drills have factory-built caps for covering feed openings; however, small pieces of cardboard or metal held in place with masking tape have served satisfactorily. The grain

[3] Soil Conservation Service, USDA. 1949-1953. Annual Technical Reports, Bellingham Soil Conservation Service Nursery. Portland, Oregon.

[4] Soil Conservation Service, USDA. 1959. Report, Annual Technical Conference. Aberdeen, Idaho.

box is then calibrated for the grass seed and the small seed box calibrated for the legume component. The tubes from the small seed box are inserted into the grain tubes for precision drilling of both species. When difficulty is encountered in calibrating the grain box for small grass seed, a seed diluent, such as bulk rice hulls or cracked grain, is used.

Grain drills not equipped with small seed boxes may be easily converted for planting grass and legume seed in alternate rows. Cross-section partitions of cardboard or plywood are placed between each feed cup opening and held in place by masking tape (figure 2). When dividers are used in grain drills equipped with agitators, a slot is cut in the dividers for the agitator rod. Two seed species, varying widely in size, can be mixed with a seed diluent so that the volume in each partition is the same. Then species are uniformly seeded with the same drill setting.

Seed Diluents

Several dilution methods to facilitate planting small seeds with grain drills have been successfully used in the field. Unprocessed bulk rice hulls, as developed by Hoglund and described by Southworth (18), have proved superior to other seed diluents, such as cracked grain and sawdust. Each rice hull acts like a small cup, retains the seed in the hulls, and prevents seed settling, thus assuring uniform distribution. Rice hulls, which are light in weight, have a rather constant size and volume; therefore, standard recommendations for their use can be made. Sixteen pounds of bulk rice hulls are mixed with the forage seeds for each acre and seeded with a constant drill setting at 160 pounds of barley.

For alternate-row seedings of grass and legume seeds of about equal size, half of the hulls are mixed with the grass and the other half with the legume seeds. When the size of the grass and legume seed vary widely, such as orchardgrass and birdsfoot trefoil, it is necessary to use a slightly larger amount of rice hulls with the legume portion than with the grass portion so that equal volumes of both mixtures will be obtained.

Where rice hulls are not commercially available, cracked grain has proved to be a satisfactory seed diluent. Lemmon and Hafenrichter (13) reported on the use of cracked and screened barley to plant simultaneously many different sizes and shapes of grass and legume seed with but a single setting of the drill. The method consisted of using a standard volume of cracked grain per acre, from which a volume equal to that of the seed to be planted was removed. The seed was then mixed with the remaining diluent. Especially uniform stands were obtained.

Advantages of Alternate-Row Seedings

Alternate-row seeding has resulted in more consistently uniform composition of grass-legume mixtures than has mixed-row seeding.

Grass in the mixture provides more protection against soil erosion, prevents or decreases runoff on sloping lands, and reduces invasion of weeds. Woods et al. (20) showed that grass-legume mixtures produced more fibrous root material for improving soil structure than did legumes sown alone. Jacobs (10) found that perennial grasses prevented the invasion of cheat into alfalfa fields. Work conducted at Bellingham, Washington, in a Soil Conservation Service nursery also showed that improved perennial grasses grown with legumes materially reduced the invasion of weeds and weedy grasses.

Grass-legume mixtures are preferred to legumes for silage. According to Porter and Skaggs (17), a preservative is usually necessary to prevent putrefactive spoilage in fresh-cut legumes. The preservative is not needed for mixtures containing 20-30 percent grass. Grass-legume hay is continually becoming more widely accepted. Keith et al. (11) have shown that good hay containing as much as 30 percent grass by weight was equal to alfalfa in fattening lambs. According to Hafenrichter (7), the optimum percentage for good hay, root production, and yield was 30-35 percent by weight of grass. When this percentage of grass was obtained, it eliminated bloat in sheep that were fed chopped hay as a part of the finishing ration.

The legume in a grass-legume mixture increases the total production, quality, and seasonal distribution of forage. In an irrigated pasture study a mixture of orchardgrass and Ladino clover with no inorganic nitrogen produced 1.74 tons more forage per acre than orchardgrass planted alone and fertilized with 180 pounds of nitrogen. W. G. Nibler reported that irrigated grass-clover pastures at Oregon State College produced significantly more pounds of beef than did heavily fertilized grass

Figure 2. Plywood dividers, held in place with masking tape, have been placed between fluted feeds to convert this grain drill for alternate-row seeding. Rice hulls will be used as a seed diluent to permit both the grass and legume seed to be seeded with the same drill calibration.

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pastures.[5] Heinemann and Van Keuren (9) reported similar results from pasture studies at Prosser, Washington. Austenson et al. (1) determined that grass-Ladino clover mixtures without nitrogen produced more milk than did heavily fertilized grass. They showed that for maximum net return, grass-legume mixtures were preferred by dairymen.

Several dairymen have established alternate-row grass and Ladino or grass and white clover pastures. These dairymen follow good pasture and animal management practices, and, to date, no additional bloat hazard or grazing problems have been encountered.

Results from pasture studies on nonirrigated land have also shown the value of the legume in the stand. Ensminger et al. (3) found that dryland grass-alfalfa mixtures produced nearly three times more beef per acre than did grass pastures in Eastern Washington. Galgan et al. (5) reported that dryland intermediate wheatgrass-alfalfa produced significantly more beef per acre than did heavily fertilized intermediate wheatgrass alone.

Current Use of Alternate-Row Seedings

Alternate-row seedings of orchardgrass or tall fescue (*Festuca arundinacea*) and birdsfoot trefoil, and orchardgrass and alfalfa have been established on hundreds of successful field-size plantings in soil conservation districts west of the Cascade Mountains in Oregon and Washington.

H. W. Miller and S. L. Swanson, in a personal communication (1959), reported that the use of the alternate-row technique is a standard practice for dryland pasture, hay and range seedings in soil conservation districts in the continental climatic zone of California. The species used are primarily alfalfa in alternate rows with Greenar wheatgrass *(Agropyron intermedium)*, Topar wheatgrass *(A. trichophorum)*, or Alkar wheatgrass *(A. elongatum)*. Miller and Swanson further reported that no problems had arisen either in grazing or cutting alternate-row seedings.

J. L. Schwendiman, in a personal communication (1959), reported extensive use of alternate rows for the establishment of grass and sweetclover, and grass and alfalfa in soil conservation districts in the intermountain area. Species being used in alternate-row seedings include birdsfoot trefoil or alfalfa with Crested wheatgrass *(Agropyron cristatum)*, Greenar, Topar, or Alkar wheatgrasses, Sherman big bluegrass *(Poa ampla)* or Hard fescue *(Festuca duriuscula)*.

Summary

A new cultural technique of seeding grasses and legumes in alternate drill rows has been used with good results in the Pacific Northwest. The important advantages of this seeding method are the elimination of competition between the grass and legume components of the mixture during establishment and the reduction of competition in subsequent years. Alternate-row seedings have resulted in consistent uniform forage composition for a much longer time than in mixed-row seedings.

Techniques that facilitate the seeding of mixtures in alternate drill rows with conventional farm equipment have been developed and used successfully.

[5] Reported in *The Grazier*. No. 34. 1954. Oregon State College, Corvallis.

REFERENCES CITED

1. Austenson, H. M., F. R. Murdock, and A. S. Hodgson 1959. *How legumes boost milk production.* Better Crops with Plant Food. pp. 22-25. July-August.
2. Chapin, W. E., A. L. Hafenrichter, and A. G. Law. 1951. *Performance of strains of* Lotus corniculatus *on the North Pacific Coast.* Agron. Jour. 43: 438-442.
3. Ensminger, M. E., H. G. McDonald, A. G. Law, A. J. Warwick, E. J. Kreizinger, and V. B. Hawk. 1944. *Grass and grass-alfalfa mixtures for beef production in eastern Washington.* Bul. 444. Wash. Agr. Expt. Sta., Pullman. 24 pp., illus.
4. Entenmann, F. M., J. L. Schwendiman, and J. K. Patterson. 1952. *Cultural methods of establishing grass with sweetclover and the effect of varying the percentage of grass and sweetclover on the crop yield.* Agron Jour. 44: 514-516.
5. Galgan, M. W., M. E. Ensminger, D. E. Foster, W. E. Ham, B. H. Schneider, J. L. Schwendiman, I. R. Adlard, and J. K. Patterson. 1953. *Grass and grass-alfalfa pastures supplemented with silage or grain for beef production in eastern Washington.* Cir. 233. Wash. Agr. Expt. Sta., Pullman. 6 pp.
6. Hafenrichter, A. L. 1956. *Better hay in the West.* Crops and Soils 8(5): 17 pp., illus.
7. Hafenrichter, A. L. 1957. *Management to increase forage production in the West.* U. S. Dept. Agr., SCS-TP-128. Washington, D. C. 16 pp., illus.
8. Hafenrichter, A. L. 1958. *New grasses and legumes for soil and water conservation.* Advances in Agronomy 10:349-406. (A. G. Norman Ed.) Academic Press, Inc., New York.
9. Heinemann, W. W., and R. W. Van Keuren. 1958. *Fattening steers on irrigated pastures.* Bul. 578. Wash Agr. Expt. Sta., Pullman. 16 pp., illus.
10. Jacobs, J. A. 1950. *Alfalfa-grass mixtures under irrigation in central Washington.* Cir. 105. Wash. Agr. Expt. Sta., Pullman. 8 pp.
11. Keith, T. P., R. H. Stark, and C. W. Hickman. 1950. *Alfalfa and alfalfa-bromegrass hay for growing and fattening lambs.* Jour. Animal Sci. 9: 491-494.
12. Kilcher, M. R., and D. H. Heinrichs. 1958. *The performance of three grasses when grown alone, in mixtures with alfalfa, and in alternate rows with alfalfa.* Canadian Jour. Plant Sci. 38(2): 252-259.
13. Lemmon, P. L., and A. L. Hafenrichter. 1947. *The dilution method for plot or field seeding of grasses and legumes alone or in mixtures.* Jour. Am. Soc. Agron. 39: 817-821.
14. MacLauchlan, R. S. 1957. *The adaptation, cultural, and management requirements of Cascade lotus.* Northwest Sci. 31: 170-176.
15. McClure, N. P., A. L. Hafenrichter, and J. L. Schwendiman. 1958. *Grasses and legumes for conservation farming in north central Oregon and adjacent areas.* U. S. Dept. Agr., Soil Conservation Service, Portland, Oregon. 23 pp.
16. McWilliams, J. L. 1955. *Effects of some cultural practices on grass production at Mandan, North Dakota.* U. S. Dept Agr. Tech. Bul. 1097. 28 pp., illus.
17. Porter, R. M., and S. R. Skaggs. 1958. *Forage and milk yields from alfalfa under three different harvest systems.* Bul. 421. N. Mex. Agr. Expt. Sta., State College. 9 pp.
18. Southworth, W. L. 1949. *Rice hulls for seeding.* Soil Conservation 14(12): 280-282, illus. July.
19. Stark, R. H., J. L. Toevs, and A. L. Hafenrichter. 1946. *Grasses and cultural methods for reseeding abandoned farm lands in southern Idaho.* Idaho Agr. Expt. Sta. Bul. 267. 36 pp., illus.
20. Woods, J. E., A. L. Hafenrichter, J. L. Schwendiman, and A. G. Law. 1953. *The effects of grasses on yield of forage and production of roots by alfalfa-grass mixtures with special reference to soil conservation.* Agron. Jour. 45: 590-595.

Land Drainage in the Mississippi Delta

W. G. EICHBERGER

Shortage in the midst of plenty! Drought in the midst of floods! The Mississippi Delta endures these anomalies of Nature all too frequently. In fact, the Delta probably has one of the greatest water problems of any region in the United States. Just as the Greek sailors of old faced Scylla and Charybdis, dual perils of shipping, Delta farmers face dual weather perils, drought and flood.

AVERAGE annual rainfall in the Delta varies from about 42 inches in southern Illinois and western Kentucky to nearly 64 inches in southern Louisiana. At first glance, it would seem that the entire Delta is supplied with sufficient precipitation for bountiful crop production. A study of the precipitation pattern, however, discloses that the moisture is not properly distributed for optimum crop production. As a general rule, more rain occurs from October to February than is needed for agricultural use. So much rain falls in March and April that seedbed preparation and planting are frequently delayed. During some years so little rain falls from May to September that drought is a hazard to growing crops. Despite the historical, real dangers of annual drought and excess rainfall, however, lack of drainage has been the primary cause of crop failure in the Delta.

It may be difficult for anyone who is not familiar with the Delta to visualize the seriousness of its drainage problem. Nor can most of those who are fairly familiar with the problem really appreciate its magnitude or its complexity without some knowledge of the physiography of the Delta—the alluvial plain of the Lower Mississippi Valley extending from Cape Girardeau, Missouri, to the gulf coast of Louisiana. The valley's topography, the ways in which its alluvial soils were formed and laid down, the characteristics of the soils themselves, as well as its rainfall pattern and man-made barriers to natural water flow, all interact to cause complex drainage problems.

Geographic and Economic Description

The Mississippi Delta is a vast area of relatively flat terrain, having an average gradient of about five-tenths per mile. It ranges in width from 30 to 120 miles and circumscribes an area of approximately 31 million acres. Some 11 million acres, or about 36 percent of the total land area, is under commercial forest cover. A little more than 19 million acres, or about 63 percent of the total land area, is in farms.

Of the total Delta area, only 4 percent lies within the boundaries of Illinois, Tennessee and Kentucky, while 96 percent lies within the States of Arkansas, Louisiana, Mississippi, and Missouri. Of the total land area in the latter four States, 22 percent lies in the Delta, ranging from 6 percent in Missouri to 46 percent in Louisiana. Thirty percent of the total cropland in these States is in the Delta. This ranges from 9 percent in Missouri to 51 percent in Louisiana.

Although the Delta has experienced a rather phenomenal industrial growth since World War II, its economy is still primarily agricultural. Cotton, corn, rice, and oats are the principal crops grown in the Delta. They account for 84 percent of the total cropland harvested. The remaining cropland is devoted to pasture, hay, and miscellaneous crops. The Delta accounted for more than half of all the cotton, soybeans, and rice acreage harvested in the four States in 1954. The Delta portion also produced 54 percent of all soybeans, 73 percent of the cotton, and 88 percent of the rice produced in the four-State region during that year.

Crop sales in the Delta accounted for 64 percent of the total value of crops sold in the four States in 1954, ranging from 39 percent of all crop sales in Missouri to 88 percent of those in Arkansas. Thus, 30 percent of the total cropland in the four States—the Delta portion—produced more than half of the total crop sales in 1954.

Livestock is less important in the Delta than in other parts of the four States. Livestock and livestock products accounted for 7 percent of the total value of farm products sold in the Delta in 1954 compared with 37 percent of total farm income resulting from livestock and livestock product sales in the four states as a whole.

Thus, the Delta has almost paradoxical characteristics: too much and too little water; large plantations and small subsistence-type farms occurring side by side; large areas of dense forest being carved into new family-type farms and large areas of former farmlands reverting to forest. In many respects, the Delta has the appearance of a frontier. This, despite the fact that much of it has been settled for more than a century.

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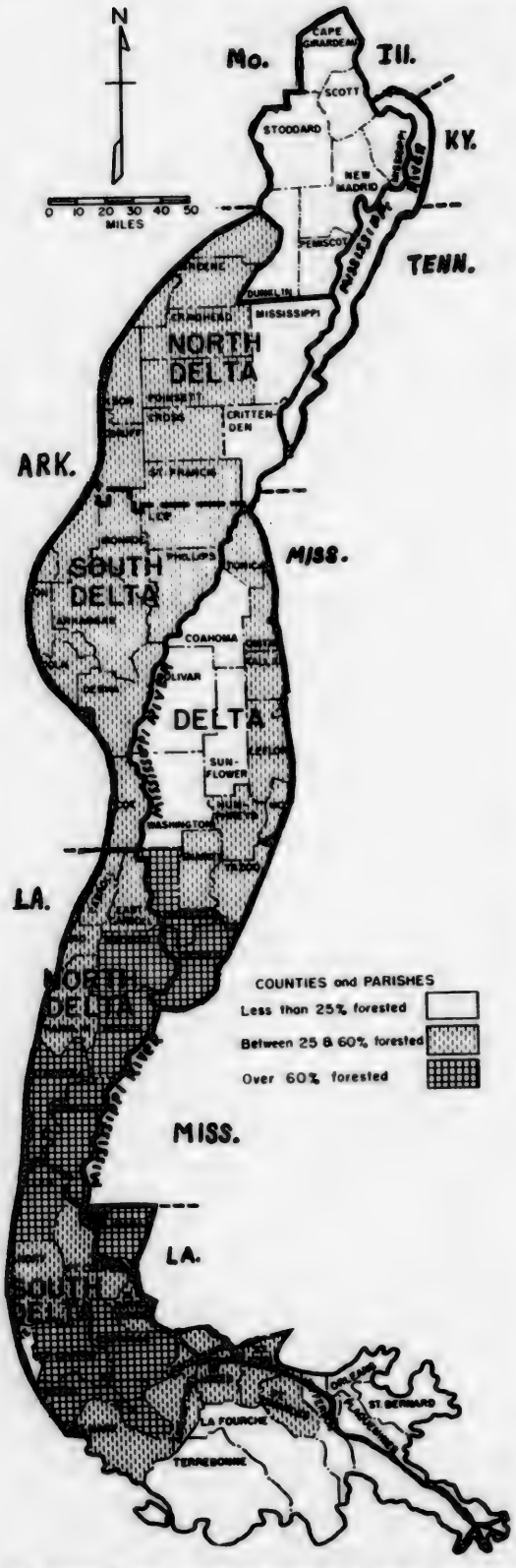

The Mississippi Delta region showing area under forest cover.

Soil Development

The Delta is flooded frequently, not so much by the Mississippi itself but by tributaries within the lower valley. Historically, a combination of circumstances made both the Mississippi River and its major tributaries such as the Ohio and Missouri Rivers kick up at the same time so that extremely large floods roared down the rich alluvial lower valley, bringing with them destruction and waste.

This long history of frequent flooding by the major streams in the valley has developed a definite soil pattern throughout the Delta. Turbulence of the overflowing water determines the types of sediment deposited in particular locations. Rapidly moving water first deposits rock, debris, and the larger sand particles. As the velocity of water is reduced, progressively smaller particles of fine sand and silt are deposited, and in quiet or very slowly moving water the finest particles of silt and clay drop out. Normally, sands are deposited near the stream, fine sands and silts a little farther away, and clays still farther away. This natural application of the laws of physics has caused the common pattern of Delta soils.

The larger streams in the Delta have built broad natural levees by depositing coarser materials along their banks during successive overflows. This accounts for the extensive areas of sandy soils found along the Mississippi River and its larger tributaries. Heavy clay soils were formed in the slack water areas some distance from the streams. Between the sandy natural levees and the heavy clay soils an admixture of soil textures from sand to silty clay is common. As the major streams have meandered back and forth within their respective valleys through time, heavy clay deposits were overlain with silts, fine sands, and sand. In general, such soils are not ideal for crop production. But in several Delta areas, this pattern of alluvial deposits has resulted in soils with a heavy, impervious clay pan. These soils are particularly suited to rice culture.

Soil and Water Management

The relatively high annual temperatures and high moisture conditions in the Delta are conducive to rapid decomposition and loss of organic matter even under natural conditions. When cultivated, soils lose their original organic matter at a greatly accelerated rate. Loss of organic matter results in an unfavorable alteration of the soil structure, a reduction in the water infiltration rate, and an increase in the runoff and erosion rates. As these conditions continue, the physical changes that result make it increasingly difficult to replenish and maintain organic matter.

Although most of the land in the Delta is almost flat, ranging from hummocky to very gently rolling, sheet ero-

sion in some sections is a serious problem. Much of the older alluvia are heavy clays with a very low organic matter content. As the infiltration rate is reduced and the runoff rate increased, large amounts of silty material are carried off. This silt is deposited in natural and artificial drainage channels and reduces water-carrying capacity. Failure to use good soil-management practices in the past has made the present water-management problem more complex. As drainage channels have become silted in, natural and artificial drainage has become less effective and flooding and overflow have increased.

In recent years, developments in agricultural technology and management practices have provided an opportunity to improve the physical condition and productive potential of Delta soils. Adoption of rotation systems that include deep-rooted legumes and winter cover crops have tended to increase organic matter, reduce erosion, and improve the physical condition of the soil. Mechanization has made possible more timely field operations so that farmers can delay operations until soil moisture is more favorable. The breakdown of soil structure by tilling when too wet is thus reduced.

Drainage

Water has been the primary factor in the formation of soils in the Delta and in its topographic characteristics. Water is also a major factor in soil management and its relation to productivity for agricultural purposes. Surface drainage to remove excess water must be provided for optimum crop production. Yet, because drought is an ever present hazard, conservation of water is of prime importance. The forces of nature and the not-altogether wise practices of man in the past have helped to compound soil and water problems throughout the area.

In general, the alluvial soils found between the natural levees and the uplands are poorly drained. This situation is to be expected because the natural levees built up along the major streams impede natural return to the stream channel. Drainage is actually away from the streams and ponding or standing water results until the surplus water can drain away slowly through minor watercourses or filter into the slowly permeable, tight, clay soils. Poor drainage, with resulting waterlogging, has prevented normal oxidation and developed the characteristic gray soils of many Delta areas.

The generally poor drainage in the Delta is partly a reflection of the heavy, tight, slowly permeable, clay soils. It also results partly from excessive rainfall and the exceedingly flat topography. But man must bear much of the responsibility for today's drainage problems in the area. Many, and probably most, of the drainage problems in the Delta are rooted deeply in historical and institutional developments of drainage.

History of Past Drainage Efforts

Earliest efforts at drainage were private developments, with each landowner attempting to drain his own land. This early drainage was carried out on "front lands," which were relatively easy to drain because they sloped away from the major streams. During the early drainage period in the 18th century, no attempt was made to drain any of the interstream area. This vast Delta area was unsettled and covered with dense forest.

The earliest attempts at drainage reclamation with Federal assistance came in the mid-19th century with the passage of the Swamp Land Grant Acts. This legislation, however, was more in the interest of flood protection than of drainage. After the Civil War, levee districts were created. These districts, which operated with some State assistance, constructed some drainage works in connection with the levee-building program. Most of the drainage construction, however, was channel construction and stream diversion to compensate for drainage by natural streams blocked by levee construction.

The first real drainage effort on the large interstream area was made during the late 19th and early 20th centuries. By then, much of the heavily forested area had been cut over. Wanting to dispose of their cut-over holdings, logging companies cooperated with railroads to bring in tremendous numbers of settlers from the Lake and Corn Belt States. This influx of settlers brought forth sufficient pressure for drainage to stimulate State legislation that would permit the formation of drainage districts. The first enabling legislation was passed during the 1890's, but relatively few drainage districts were organized before 1900 and from 1900 to 1909 inclusive less than 100 drainage districts were established, most of them during the last 5 years of the decade. Between 1905 and 1915, the States revised their drainage district laws in the light of experience. During the period 1910-20, the organization of drainage districts reached its peak in Mississippi and Arkansas, and proceeded at an increased pace in Louisiana and Missouri.

Little thought was given to coordination of some drainage works constructed by individual districts, to their effects on other existing districts, or on areas not yet served during this period of rapid drainage development. For example, natural watercourses were used as outlets for multiple drainage districts, with little attention paid to the carrying capacity of the streams. Drainage problems were increased thereby. Continued land-clearing activities and resulting higher runoff rates complicated the problem still further.

As drainage in existing developments became less effective, crop yields declined. More and more land being drained would not provide enough increased production

to pay for the needed improvements and maintenance of the drainage systems. By the midtwenties, drainage districts throughout the Delta were in serious financial trouble.

The great flood of 1927, which covered most of the alluvial valley, ended this era in the Delta's drainage movement. Many of the districts had to be reorganized and refinanced and as a result rehabilitation was extended over a long period. During the period 1930-1939, relatively few additional drainage districts were organized, and most of the new ones covered comparatively small areas.

Interest in drainage revived in the forties. More new drainage works were installed in Louisiana during this decade than in any previous 10-year period. Drainage work outside Louisiana, however, was more reconstruction than new development. Inefficient and inadequate drainage works forced many drainage districts to rehabilitate their old systems.

Present Drainage Situation

Improper maintenance of many ditches, inadequacy of major drainage outlets, increasingly intensive technology of agriculture, and greater knowledge about the rivers in the valley have made it apparent that the engineering, legal, and institutional aspects of drainage must be revised if an effective overall Delta drainage system is to be realized. Louisiana, in particular, has taken steps to coordinate all drainage activity in the State. Through its Department of Public Works, the State has helped to consolidate small drainage districts into larger organizations, many of them parishwide. The State is also assisting in the engineering, management, and financing of newly formed, enlarged districts. Furthermore, all drainage work proposed within the State must first be approved by the Department of Public Works.

Federal drainage programs now can relieve many of the physical and engineering problems that face drainage districts. Federal assistance in planning and installing works of improvement has been provided in varying degrees for a number of years. However, in the Flood-Control Act of 1944, Congress for the first time authorized major drainage improvements as a purpose in the overall flood-control program carried out by the U. S. Army Corps of Engineers. Main channels serving many drainage districts can be improved with Federal assistance under this Act. The Corps of Engineers was for the first time instructed by this Act to engage in drainage work not directly related to levee building and other flood-control projects. Since the Act was passed, the Corps of Engineers has done considerable drainage improvement. The work has consisted of snagging, clearing, and realigning channels, and constructing new major outlets.

The drainage problem in the Delta can be alleviated further under the Watershed Protection and Flood Prevention Act of August 4, 1954. This Act authorized the Department of Agriculture to cooperate with other Federal agencies, States, and local groups in planning and carrying out works of improvement in soil conservation, land drainage, and related activities.

Massive drainage programs, such as those planned by the Corps of Engineers, and small watershed programs as planned by the Department of Agriculture, are sharp tools for use in solving drainage engineering problems. These programs, which are planned on a hydrologic unit basis, enable drainage work to start at the bottom of the watershed and work toward higher land, a fundamental criterion of drainage engineering. While these programs will solve some of the engineering problems, they will not solve those resulting from poor coordination among existing drainage districts. The Federal drainage programs may provide the stimulus, but the actual solution of many of the legal and institutional problems of drainage will have to come largely through harmonious effort on the part of local people.

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Control of Aquatic Weeds in Farm Ponds

ALEX MONTGOMERY

Most farm ponds, unless properly constructed and diligently managed, will sooner or later become infested with troublesome aquatic weeds, many to the extent of severe interference with their primary functions. The control of aquatic weeds has for many years been necessary in the management of fish populations in small bodies of water. The great number of privately owned farm ponds and the increasing interest in their management for recreation has made aquatic weed control an important aspect of fishery management.

AQUATIC PLANTS can be either desirable or undesirable, depending upon the conditions under which they exist and the manner in which the water area containing them is used. In certain instances, some aquatic plants are highly desirable in that they furnish food and cover for fish and game, however, in small farm ponds most plants are undesirable in that they interfere with proposed water uses of the pond.

The control of undesirable aquatic weeds has been accomplished through several methods.

1 Fertilization of the water for production of microscopic algae in numbers sufficient to reduce light penetration into the water and in effect shade out plant growth on the pond bottom. This method effectively prevents new growth of aquatic weeds, however, it isn't effective in eliminating established weed infestations. Due to variations in water conditions, climate, and growing seasons in different areas of the United States, it is necessary to use the fertilizer (formula) and rate of application adapted to the particular area of the country where treatments are made if good results are expected.

2 Manual removal of undesirable plants through cutting or pulling. This method is quite effective in eliminating plants of the emergent type (cattails, arrowhead, waterlilies, pickerel weed, etc.) if removal is initiated and continued so as to prevent seed production. Three to five cuttings may be necessary during the first year, and in most instances it is desirable to initiate a fertilization program to retard regrowth after cutting.

3 Exposure of the pond bottom to winter weather conditions. In areas of the United States having severe winter weather conditions, ponds having ample water supplies and adequate draining facilities are often drawn down during the winter months to expose weed infested bottom areas to freezing and thawing. This method serves to give seasonal control of a number of the submerged aquatics. However, it is now thought that winter draw-down must be practiced for a three year period to eliminate weeds. There is every possibility that drawdown would have to be continued in later years to prevent re-infestation.

4 Chemical aquatic weed control in which suitable chemicals are applied to the plants which they effectively eliminate.

Through experience, it has been established that of the existing methods, chemical aquatic weed control usually is the most economical and effective means of eliminating water weeds.

There is no one chemical which will control all aquatic weeds. The large variety of weeds in this group are of several different types and do not respond to the same treatment. This makes necessary the use of specific chemicals on specific types of plants if satisfactory results are to be achieved. Due to the lack of suitable chemicals, until recently, chemical aquatic weed control has been accomplished through the use of only a few herbicides.

Chemical Aquatic Weed Control

For general control of *submerged* aquatic weeds (plants which grow beneath the water), sodium arsenite solution has been used almost exclusively. This material is a nonselective chemical and when introduced into the water in concentrations ranging from 4 to 10 parts per million, kills submerged aquatic plants of all types. The use of this chemical presents disadvantages in that it is very toxic to warm blooded animals, and has been found to build up in residual concentrations when used repeatedly. However, this aquatic herbicide is still in extensive use for aquatic weed control due to its effectiveness in controlling submerged vegetation and the fact that a large number of aquatic plants can be controlled only with this material.

To control the *emergent* aquatic vegetation (plants growing from the lake bottom with leaf parts extending above the water surface) and, for the most part, floating aquatic plants (waterlilies, watershield, waterlettuce), 2,4-D and 2,4-D—2,4,5-T combinations have been extensively used. Treatment consists of mixing ester formulations of these growth regulating herbicides at the rate of ½ pound plus 1 pint of detergent in 10 gallons of water

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SCS Photo by Clark

SCS Photo by Clark

Photographs of Ocean Township Municipal Pond, Monmouth County, New Jersey. The photograph on the left was taken before treatment with pelleted 2,4-D. The picture on the right shows the excellent aquatic weed control achieved.

carrier and spraying on exposed plant parts. Certain of the more hardy, narrowleaf plants (cattail, bullrush) respond much more readily to this type of treatment when fuel oil is used as a part of the carrier.

The control of some forms of algae (filamentous and plankton) is still most economically and effectively accomplished through the use of copper sulphate. This chemical either broadcast or placed in a loose woven bag and dragged in algae infested areas to give an application rate of 0.5 to 1.0 parts per million (1.35 to 2.7 lbs. per acre-foot of water treated), depending upon the water hardness, quickly eliminates algae infestations.

More recently, widespread interest in the control of aquatic weeds has motivated the rapid development of a large number of new aquatic herbicides. The screening of many of these newer materials has indicated that different forms or derivatives of the growth regulating type herbicides show great promise for the control of aquatic vegetation. Of the newer aquatic herbicides, 2,4,5-trichlorophenoxypropionic acid shows promise of controlling broadleaf aquatic vegetation. This liquid emulsive is introduced into the water to build up a concentration of from 1.5 to 3 parts per million. However, any appreciable inflow of water into an area being treated must be taken into consideration or dilution below toxic levels may occur. This chemical has been used effectively in controlling broadleaf submerged and emergent aquatic weeds.

One of the most promising of the new aquatic herbicides is pelleted 2,4-D. Pelleting puts 2,4-D, one of the most effective herbicides, in a form which is applicable for use in a water medium. The pellets contain the insoluble ester form (25 percent active material) of this powerful and effective chemical along with other components which slowly release the 2,4-D. When applied in weed infested areas at the rate of nearly 150 pounds per surface acre, this material effectively controls many broadleaf submerged and emergent aquatic plants. This type of aquatic herbicide is easily applied by hand or through use of manual or powered seeding equipment. Further, its components are not toxic to warm blooded animals or fish in the concentrations used and prolonged control has been realized on certain plant species. Pelleted 2,4-D, due to the unique release of its chemical, overcomes the water dilution factor, and is effective for spot treatments of individual weed patches within a pond as well as for weed control in areas of considerable water flow.

In the control of aquatic weeds with chemicals, the time of the year at which treatments are made is important regardless of the aquatic herbicide being used. Generally, applications made in the spring and early summer produce most rapid and effective results as the plants are young and tender and are growing rapidly. Treatments made in late summer and fall when plants are tough and mature and are growing slowly require higher rates of application for effective control. The visible results realized from late treatments are slow in appearance and often the effectiveness of control is erratic.

There is no permanent cure-all for aquatic weeds, and their control is a never ending process. Some aquatic herbicides give only seasonal control of plants while others give control for longer periods of time. Most, however, damage the initial infestations to the extent that control in succeeding years usually resolves itself into treatments of regrowth resulting from viable seed germination or spots missed during initial treatment. Diligent treatment of plant regrowth is a necessity for not only does it minimize the effort necessary for future control but it prevents plant infestation in the pond.

Land Leveling Can Adversely Affect Soil Fertility

MARVIN D. HEILMAN AND JAMES R. THOMAS

THERE ARE APPROXIMATELY 175,000 leveled acres in the three lower counties of the Rio Grande Valley. Land leveling is recognized as being of tremendous value to valley agriculture. Better distribution of irrigation water and rainfall through land leveling has increased crop production. This production can be further increased after land leveling by the use of soil improving crops and fertilizers applied to the cut areas.

Reduced yields and nutrient-deficient crops on cut areas after land leveling are problems that have been recognized in many areas of the United States. Whitney et al. (3), reporting on work conducted in Colorado, make the statement that "unfortunately some operations tend to leave fields or spots in a field void of part or all of the surface soil." Their study indicated that on a highly calcareous soil, the removal of only 3 to 6 inches from the plow layer greatly reduced the nitrogen and phosphorus available for plant growth. Harmful effects of land leveling, resulting from subsoil being exposed by the cut, are comparable to the removal of the surface soil by erosion.

Carlson and Grunes (2) took varying amounts of a calcareous loam soil and mixed the different horizons. Mixtures of the surface and subsoil resulted in increased yields as the percentage of surface soil in the mixture was increased. Subsoils of this calcareous soil were low in available nitrogen, phosphorus and zinc. Burnett and Fisher (1), reviewing problems associated with leveling, found that because of pulverizing and packing, land leveling materially affects physical properties of the soil. The organic matter and a majority of the microorganisms are present in the surface horizon of most soils. When this horizon is removed soil fertility is reduced.

Practices Following Leveling

As a prelude to a fertility experiment, a tract of Hidalgo sandy clay loam in Texas was leveled in 1957. Half the block was cut to an average depth of 0.5 foot and the other half was filled. This soil is moderately supplied with available nutrients and is very calcareous throughout the profile.

After leveling, three crops of forage sorghum were grown for soil improvement. The first sorghum crop was fertilized with 200 pounds of ammonium sulfate per acre applied to the cut area. Oven dry forage yield in 1957 was 3,485 pounds per acre less on the cut area than on the fill area in spite of the fertilization of the cut area. The yields for the cut and fill areas were 5,924 and 9,409 pounds per acre, respectively. In 1959 the cut area produced 11,200 pounds per acre of forage whereas the fill area produced 14,020 pounds per acre, a difference of 2,820 pounds per acre. The three crops of sorghum did not materially change the productivity differential between the cut and fill but had considerable value as a soil improving crop for forage yields increased with each succeeding green manure crop.

Cut and Fill Area Fertility Differences

Soil samples for chemical analysis were taken in March, before the forage sorghum was planted in April 1959. These analyses showed that the cut area had a much lower nutrient level than did the fill area (table 1). Nitrate nitrogen in the fill area was double the amount of nitrate in the cut area. The different levels had an effect on both sorghum yield and nitrogen fertilizer response.

TABLE 1

Availability of Nitrogen and Phosphorus in Cut and Fill Areas of a Leveled Field in 1959[1]

Soil characteristics	*Cut*	*Fill*
	Pounds/Acre	*Pounds/Acre*
Nitrate nitrogen	53.6	93.2
Mineralizable nitrogen[2]	135.4	160.6
Phosphorus available	16.0	24.3
Soluble salts	1228.0	1112.0

[1] Available nutrients in the first 3 feet of soil.
[2] 14 day incubation with initial nitrates excluded.

One of the consequences of soil organisms feeding on organic matter is the conversion of nutrients from a relatively unavailable form into forms available for plant growth. The difference in mineralizable nitrogen between the cut and fill area shows that organic matter and microorganisms were moved from the cut to the fill area (table 1).

Crops grown on soils that have less than 20 pounds per acre available phosphorus would probably be phosphorus deficient. The cut area is below this phosphorus level whereas the fill area has an ample supply. In most soils of the Lower Rio Grande Valley approximately one-half of the available phosphorus is in the surface foot of soil.

Effects of Nitrogen Fertilizer

The fertility of the cut and fill areas was reflected in the sorghum yields obtained in a soil fertility-residue management experiment in 1959 (table 2). The check plots (no nitrogen applied) yielded 2,820 pounds per acre

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TABLE 2

Effect of Nitrogen Fertilization on Yield and Nitrogen Content of Sorghum Forage in 1959[1]

Nitrogen applied	*Forage Yield*		*Nitrogen content*	
	Cut	*Fill*	*Cut*	*Fill*
Pounds/Acre	*Pounds/Acre*		*Percent*	*Percent*
0	11,200	14,020	0.847	1.147
180	12,720	13,360	1.202	1.302

[1] Oven-dry weight basis

Figure 1. Sudan grass following four soil-improving and one cash crop still reflects the fertility status of the cut and fill areas. The grass on the left is from the fill and the grass on the right is from the cut area.

less on the cut than on the fill area, and the nitrogen content of the forage was 0.3 percent less. The cut area with nitrogen applied at the rate of 180 pounds per acre produced 1,300 pounds less forage than the check plot of the fill area. The low yield on the cut area was due primarily to a nitrogen deficiency brought about by the removal of the organic matter. Sorghum yields and the nitrogen content of the sorghum were significantly increased by the application of nitrogen fertilizer to the cut area. There was no significant increase in sorghum yields from the application of nitrogen fertilizers to the fill area, although the nitrogen content of the forage was increased.

Percentage nitrogen recovery from nitrogen fertilizer was greater on the cut (40 percent) than on the fill area (8 percent). No increase in yield was gained from a high rate of nitrogen application on the fill area. The cut area would require 345 pounds of nitrogen per acre to produce yields equal to that produced on the nonfertilized fill area.

The difference between the cut and fill area is still reflected in the growth of sudan grass following four soil improving crops and a cabbage cash crop (figure 1).

Recommendations

Corrective measures can be initiated to minimize the fertility problems associated with land leveling. Soil samples should be taken from both cut and fill areas to determine the true fertility condition of the field. Normally a larger amount of fertilizer will be required on the cut than on the fill.

Proper agronomic practices should be employed to correct fertility and other soil problems associated with land leveling in order to realize the full benefit of leveling. Poor physical condition of the soil existing after leveling operations can be corrected by growing soil improving crops, such as forage sorghums, clovers and other high residue-yielding crops. To obtain maximum benefits from such crops they should be fertilized if necessary and plowed into the soil. Decay of these materials improves the soil physical condition and provides available nutrients for the following crops.

REFERENCES CITED

1. Burnett, Earl and C. E. Fisher. 1956. *Land leveling increases dryland cotton production.* Tex. Agri. Expt. Sta. Progress Report 1914. Weslaco, Texas.
2. Carlson, C. W., and D. L. Grunes. 1958. *Effect of fertilization on yield and nutrient content of barley.* Soil Sci. Soc. Amer. Proc. 22:140-145.
3. Whitney, R. S., R. Gardner, and D. W. Robertson. 1950. *The effectiveness of manure and commercial fertilizers in restoring the productivity of subsoils exposed by leveling.* Agron. Jour. 42:239-245.

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A ballot will be mailed to every member who has paid his annual dues by April 1, 1961. Make sure your dues are paid—don't miss the boat—and your vote. Ballots for the Society-wide elections to name officers and Council members will be mailed in mid-April.

Use and Returns from Reservoir Areas

NATHAN G. MALLETT

THE SMALL WATERSHED PROGRAM has many characteristics that are unique among flood-control efforts carried forward under the authority of Public Law 566 and its amendments. Among the features of flood-control with which local people are concerned are easements and rights-of-way for the floodwater-retarding structures. The cost of these items is included as part of local contributions for the project and are normally donated by landowners in the watershed.

The United States Department of Agriculture Appropriation Act of 1954 included a watershed-protection item which provided an initial $5,100,000 and authorized $28,706,000 for pilot watersheds in a limited number of small stream areas. These pilot projects were designed to demonstrate the effectiveness of a complete soil and water conservation program. The legislative history of this program reveals that it was also the intent of the Congress that evaluation studies be made on pilot watersheds to determine benefits derived from these installed practices.

Economic evaluations are now underway on some of the pilot watershed projects attempting to measure the effects of ponding and periodic flooding on use of land and water in these reservoir sites. These studies should also be useful in planning procedures for watershed development in other areas.

Study of a Watershed

Six Mile Creek Pilot Watershed, located in west-central Arkansas, was one of 62 watersheds selected for the pilot program. The project was sponsored by the Franklin County and Magazine Soil Conservation Districts and technical assistance was provided by the Soil Conservation Service.

The economy of this area is still largely dependent upon agriculture, with dairying the predominant enterprise. The watershed contains approximately 164,000 acres, nearly 16,000 of which are in the Ozark National Forest. There are two incorporated towns and five smaller communities in the watershed. There are about 800 farm owners and operators in the area, and some 300 have land that is subject to floodwater and sediment damage. Around 36,000 of the 48,000 acres in these farms are used for pasture and the rest, which is primarily in the flood plain, is used for feed production and cash crops.

The watershed-treatment program developed for this area included land-treatment measures designed primarily for watershed protection and structural measures for flood prevention. Land-treatment measures were designed to keep surface run-off at a minimum and maintain a high level of production. Structural measures consisted of 26 floodwater-retarding structures, 29.6 miles of channel improvement, and stabilization of 350 acres of critical erosion and sediment-producing areas. It was estimated that the above program would reduce flooding 80 percent and damages by 74 percent.

Reservoir Land Use and Returns

When construction began in 1955, it was estimated that 2,212 acres of land would be involved in 26 flood and sediment pools. The fills to form these pools were to be compacted earth type with vegetated spillways. The flood pools ranged in size from 268 to 1,490 acre-feet storage space capacity with the average capacity being 774 acre-feet. The storage capacity of sediment pools averaged 101 acre-feet, ranging from 25 to 270 acre-feet in size. All of these structures were to be of the single-purpose flood-prevention type.

Use made of the 2,212 acres required for these structures in 1954 was 1,973 acres (89.2 percent) in pasture, 144 acres (6.5 percent) in cropland, and 95 acres (4.3 percent) idle.[1] Structure sites are normally in the upper reaches of tributaries where land use is not very extensive and production is low (figure 1). Gross income for the 2,212 acres as a whole was estimated at only $8,605 for 1954. It was further estimated that in the absence of any improvement program, floodwater damage to crops and pasture would amount to $1,370 annually. Deduction of these damages left a net gross income of $7,235 for the total area, an average of $3.27 per acre.

In the planning process, deductions were made for the production loss from 686 acres that would be under water

Nathan G. Mallett is agricultural economist with the Farm Economics Research Division of the Agricultural Research Service, Little Rock, Arkansas.

[1] A study, the joint effort of the Soil Conservation Service and the Agricultural Research Service, is currently being made in the Six Mile Creek Pilot Watershed. This study is the basis for this paper.

Figure 1. (Left) Typical pasture land on reservoir sites prior to installation of floodwater retarding structures.

Figure 2. Improved pasture resulting from seeding and sodding of floodwater retarding structure and spillway.

in the sediment pools and 763 acres (one-half the acreage) in the flood pools. It was realized that the areas in the flood pools would be subject to flooding at various times and over long periods and that this would reduce production considerably.

Estimates of gross production per acre that would have been realized in the reservoir areas are given in table 1. These values were calculated from a production index developed from sample study areas scattered throughout the watershed.

With 24 of the floodwater-retarding structures installed by 1959 the project was essentially complete. Use made of land in the area in 1959 was 1,325 acres in pasture, 21 acres in cropland, and 180 acres idle. Included in the pasture was approximately 150 acres of seeded and sodded structures and emergency spillways which were available for controlled grazing. It is estimated that production from these areas averaged 5.0 animal unit months per acre grazing as compared with an average of 1.5 animal unit months grazing per acre on pasture before project construction (figure 2).

Actual gross income per acre has increased in each of the last 5 years, even though as construction progressed more and more land was taken out of production by the floodwater-retarding structures (table 1). Actual crop and pasture income for each year the project has been in operation has averaged 40 percent higher than that anticipated when the project was planned. Some floodwater damage to pasture has occurred, especially in 1957 and 1958 when rainfall was abnormally high during the spring. These damages have amounted to less than 6 percent annually.

Water Use

In 1955, arrangements were completed to use water from two of the sediment pools as a supplement to the existing water supply for the ctiy of Booneville, Arkansas, which lies just south of the watershed boundary. Owners of these two pools receive $800 annually for this water. Water from another of the reservoirs was purchased from the owners in 1957 for an annual fee of $360 and is being used by a manufacturing company. Three of the lakes have been leased to clubs on an annual basis for a total of $550. Total cash returns from the sale of water stored in all sediment pools has been $800, $1,180, $1,990, $1,992, and $1,495 for the years 1955 through 1959, respectively. These returns are future values that were not considered during the planning stages of this project. It is apparent that wherever water is available industry and individuals are willing to pay for it.

Records of the study to date reveal that farmers on whose land the floodwater-retarding structures have been built received more in-

TABLE 1

Actual and Estimated Gross Income per Acre from Reservoir Areas and Floodwater Damages—Long-Term Prices

Year	*Estimated Income Without Program*	*Actual Income Received*			*Estimated Income With Program*	*Flood Damage*	*Net Increased Income*
		Crop Income	*Other Income*	*Total Income*			
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
1954	3.89	2.86	0	2.86	—	—	—
1955	3.35	4.32	.52	4.84	2.47	0	2.37
1956	3.07	4.83	.77	5.60	2.26	0	3.34
1957	5.20	4.49	1.30	5.79	3.70	.29	1.80
1958	5.82	5.20	1.31	6.51	4.29	1.15	1.07
1959	6.27	5.24	.98	6.22	4.62	.35	1.25

A permanent home . . .

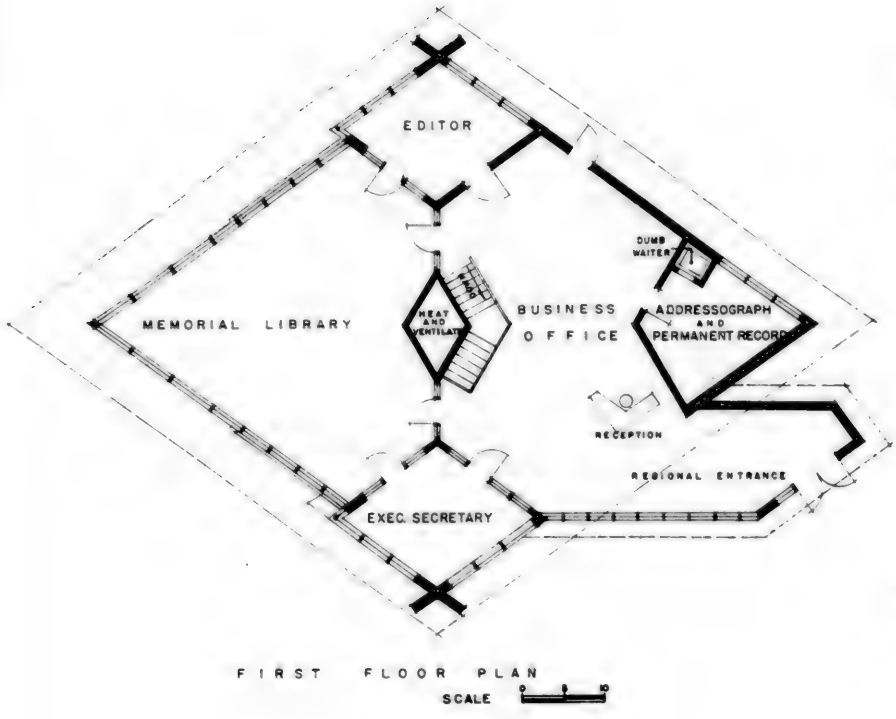
It shall be builded not only of stone, mortar, and the woods of the forest, but of the spirit of the founders of the Society and devotion of its members.

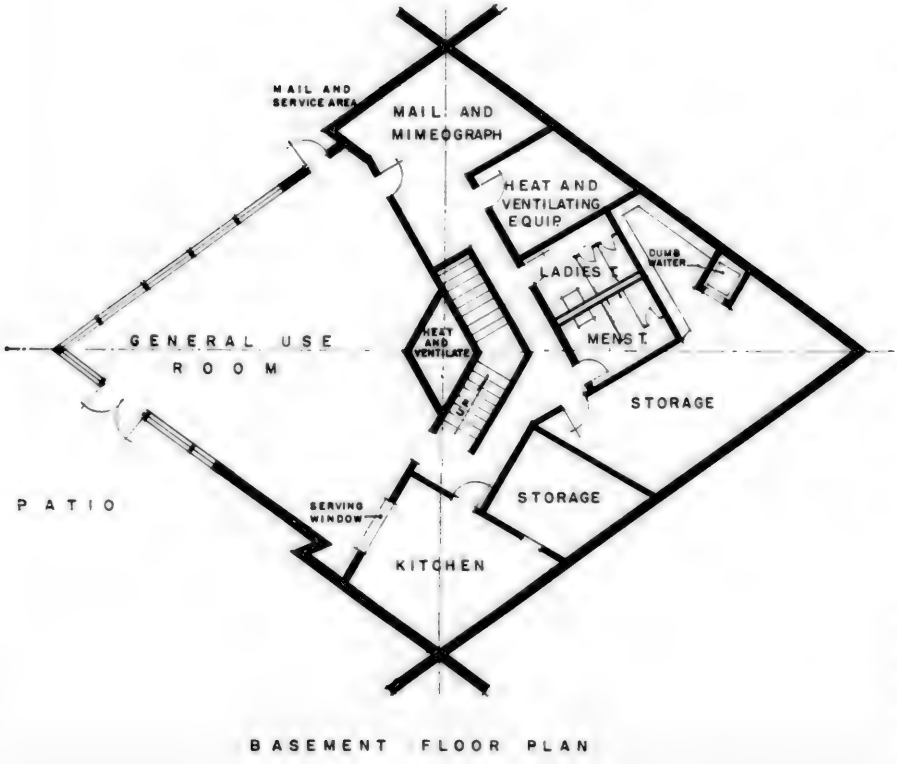
It shall stand not only as a tribute to the service of those who have preceded us and to our accomplishments, but as an inspiration to those who will continue to carry on the research, education and service required in conserving our renewable natural resources.

Soil Conservation Society of America

New Home for a Growing Society . . .

. . . simple yet dignified, beautiful yet efficient





In the beginning . . .

For nearly two decades the Soil Conservation Society of America has been dedicated to promoting and advancing the conservation and improved use of our renewable natural resources. The Society is founded on the precept that these renewable resources are indispensable to the support and growth of strong, prosperous and free nations; and that everlasting resource abundance is dependent upon the development, coordination, and proficient application of the several arts, sciences, and professions having to do with resource management.

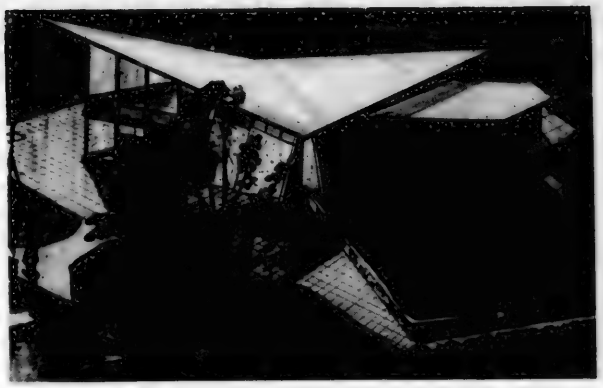
Progress has been made and influence gained through the vision of the founders of the Society and the organized efforts of its members. Hundreds of conservationists have gained skills and developed abilities that might never have been used but for the challenges received through the Society and its members. The Society has played vital roles in action programs, in establishing resource-use policies on local, regional and national levels, and in inspiring public concern for the future of our renewable natural resources.

Steady growth . . .

As of July 1945, SCSA had 341 members. Today, more than 10,500 men and women are active in its 110 working chapters. Growth means an ever-increasing volume of work is required of the central office. The employment of an executive secretary, a full-time editor for the Society's JOURNAL OF SOIL AND WATER CONSERVATION, and the clerical staff required to deal with the insistent demands of the chapters and their membership have put a heavy strain on the physical and financial resources of the Society. This load will increase at an even faster pace as the Society continues to grow.

"When we build . . . let it not be for present delights, nor for present use alone, let it be such work as our descendants will thank us for, and let us think . . . that a time is to come when these stones will be held sacred because our hands have touched them, and that men will say as they look upon the labor, and the wrought substance of them, 'See! This our fathers did for us!'"

—JOHN RUSKIN



The Society acts . . .

Recognizing the urgent and immediate need for a permanent home for the Society in keeping with its growing importance and the great increase in work required of its staff, the Council began studying various housing possibilities early in 1959. Unanimous Council action in August 1959, endorsed a proposal to secure a building site near Des Moines, Iowa, and to erect the headquarters-home of the Society on it. A Housing Committee was named and a Building Fund Committee was appointed to solicit funds.

In March of 1960, the Council approved selection of a park-like 4.6-acre site on gently rolling slopes immediately north of the city of Des Moines. Though the site is easily accessible from the business area of the city and to air and rail transportation terminals, it lies in an agricultural area typical of rural Iowa. Directly across the highway lies the 1600-acre Iowa State University experimental farm. A 99-year lease of the area was granted by the Iowa State University for $1 per year.

Architectural development . . .

After studying space needs and allowing for future growth, the Council agreed unanimously on this plan. Each floor will have 2,970 square feet of space. Non-bearing interior walls give maximum flexibility.

Committee and council meetings can be held in the library. Larger groups can meet in the general use room until it is needed for future growth. Even adding to the structure is possible without detracting from appearance or modifying the design.

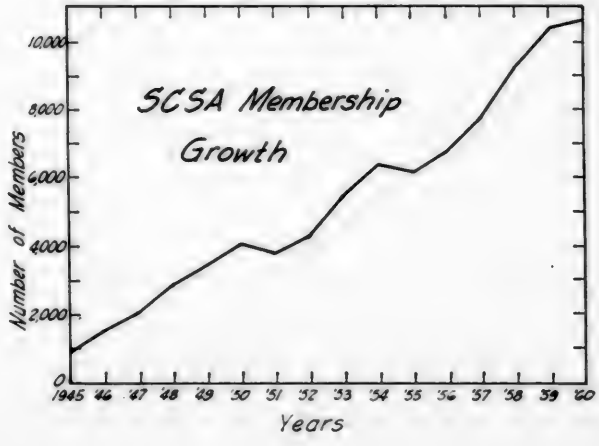
The hyperbolic-paraboloid thin-shell concrete roof design is economical, both in use of material and in construction cost. This simple, yet dignified, exterior reflects an awareness of the future, a mark of the conservationist.

And they did build . . .

Architects' estimates place the building costs at $100,000. Members of the Soil Conservation Society of America and its friends are being asked to finance this structure. In addition to any lump-sum gifts and pledges to the building fund, sustaining memberships in the Society, above the regular dues will be applied toward building construction unless otherwise stipulated by the donor. Individuals and institutions are encouraged to become sustaining members.

An equal share in the building cost for each member of the Society would be $10. Some may contribute less than this amount. This means that others must give more. Substantial contributions from those who can make them will be decisive, of course, for the program is a big one —big in the work that must be done, and historic in the high promise it offers all to play an important part in the progress of the Society.

Special contributions to help finance or furnish the building can be made in the memory of individuals. These will be appropriately recognized and permanently recorded in the structure.



This is the schedule...

The decision to erect a permanent home for the Society was made in 1959. Since then the site has been selected and the building design has been approved.

Detailed floor plans and finished exterior sketches were delivered in March 1961. Specifications and working blueprints are due in June.

Contingent upon the Society having 60-70 percent of the estimated $100,000 necessary to build, contracts will be awarded in July of 1961. Ground breaking ceremonies are planned one month after contract letting and plans call for building occupancy in March of 1962.

Success depends on you...

Success depends on raising the necessary funds to finance erection of this permanent home for the Soil Conservation Society of America. As we unite to construct this headquarters building in memory of the man who founded the Society, we pay tribute to our pride in its accomplishments, and to our belief in its future by generous support.

Please do this NOW!

Complete the gift and pledge form on page 90 of this issue of the JOURNAL.

Mail to: Soil Conservation Society of America, 838 Fifth Avenue, Des Moines 14, Iowa, or to your chapter secretary.

HUGH HAMMOND BENNETT

This building will be dedicated to the memory of the late Hugh Hammond Bennett, "Father of Soil Conservation" and founder of the Soil Conservation Society of America. To thousands he passed on his crusading zeal against wasteful exploitation of the soil and other renewable natural resources. To others he bequeathed a concept of integrating all scientific knowledge and technical skill so that each acre of land would be used in keeping with its potentialities and treated according to its needs.

As head of the Soil Erosion Service established by the United States Congress and later as chief of the Soil Conservation Service, Bennett's timely and forthright action in halting the insidious spread of erosion and depletion of soils has affected the well-being of uncounted millions of people now living and yet to be born.

Across the face of the earth are many living monuments to this man—monuments formed of productive soil and the crops thereon, of lush pastures and fat cattle, where before his coming lurked the threat of hunger as erosion tore gaping holes in unprotected land. As the Soil Conservation Society of America is international in scope, this building as a tribute to Dr. Bennett will attest to his world-wide renown.

The building will house a library containing a number of Dr. Bennett's personal writings and the history of the science and art he founded.

(Remove this insert for complete view of building and site.)

come from these areas than was expected when the local organization agreed to undertake the project. Over the 5-year period, estimated total gross income after deducting expected annual damage has averaged approximately 97 percent of that which would have been received from this area had no project been installed.

Availability of water has made it possible for this area to obtain two industries that will add something like $750,000 annually to the local economy. These two plants employ about 600 people and most of them live within the watershed's boundaries (figure 3). This will make possible a better standard of living in this area of chronic underemployment and will provide supplemental income to boost the sagging farm income typical of this and other areas of the South.

The 5-year period since the inception of the small watershed approach to alleviating floodwater and sediment damage in this local area has proved the value of this type of program in overall soil and water conservation. Installation of land-treatment measures has reduced surface runoff and erosion, as well as increased production. It is estimated that structural measures have produced an average annual direct benefit of $41,800, and monetary returns from use made of stored water has averaged about $1,500 annually.

These are direct benefits from the program. Indirect benefits to the area from the two industries would probably amount to considerably more than the direct benefits that have been discussed. The aesthetic and recreation values added by these lakes cannot be reduced to dollars and cents, but they have added much to the communities in which they are located.

Figure 3. Aerial view of Seampruf Manufacturing Company plant showing floodwater retarding structure and pool from which water supply is obtained.

From an address delivered at the 15th Annual Meeting of the Soil Conservation Society of America.

"Conservation is so important and farming is so important, we do need the Nation's best to man our farms. However learned our soil scientists, however broad their vision and sound their programs, it is only the the portion of such programs which farmers implement that counts."

—Lawrence Kerr

Book Reviews

From Theory to Practice in Soil Mechanics. *Edited by* L. Bjerrum, A. Casagrande, R. B. Peck, A. W. Skempton. *425 pp., illus., bibl., 1960. John Wiley and Sons, Inc., 440 Park Avenue South, New York 16. $12.00. (Reviewed by* FIRMAN E. BEAR, *New Brunswick, New Jersey.)*

Karl Terzaghi was born in Prague, in 1883, educated in the Technische Hochschule, Grasz, Austria, got his first job with a company that specialized in reinforced concrete, found greater interest in soil mechanics, was called back and forth to various positions in the United States and Europe, became a world-wide consultant in the construction of earth dams and foundations, and grew to be the recognized leader in this phase of engineering throughout the world.

Part I of this highly interesting volume gives his life history, which merits reading for its inspirational value. Part II covers the aim, scope and methods of soil mechanics as outlined in Terzaghi's publications. Part III contains 18 selected professional papers of his. Part IV consists of five reports, including a Chicago subway project, design of a Madras cofferdam, report on a proposed British Columbia storage dam, and a memorandum on a South American landslide. Part V is a bibliography of 256 papers published by Terzaghi and his associates.

Soil-conservation physicists will find this a highly informative book to read, with much theoretical and factual material that can be applied to their fields of study. The editors have rendered a highly important service in the preparation of the material for this well illustrated and very attractive volume.

Water for the World. *By* ELIZABETH S. HELFMAN. *213 pp., illus., bibl., index, 1960. Longmans, Green and Co., 119 West Fortieth Street, New York 18, N. Y. $3.75. (Reviewed by* BRYCE C. BROWNING, *New Philadelphia, Ohio.)*

In this book the author attempts to tell the story of water and of its ever increasing importance to mankind. Dedicated to her son, it is apparently aimed at young people of pre-college age. However, it could be quickly and profitably read by anyone seeking general information on the subject.

Mrs. Helfman first discusses the hydrologic cycle and water as a chemical phenomenon. In the following chapters she demonstrates man's complete dependence upon it, how greatly it has influenced his civilization, and how it has now become his most critical resource problem.

In presenting her subject the author traces man's relationship with water from the beginning of civilization to the present time. In this process she explains how it has been a primary influence in the location of population centers, in causing wars and in the economic success or failure of nations. She places particular emphasis on the continuing tendency of mankind to fail to anticipate water problems—"not to miss the water 'till the well goes dry"—and the terrible price paid for this lack of foresight.

Mrs. Helfman claims no authority in the water field nor does she attempt to offer new answers to the water problem. She has assembled a considerable amount of pertinent information and presents it in an interesting manner.

Private Grazing and Public Lands. *By* WESLEY CALEF. *292 pp., illus., maps, index, 1960. The University of Chicago Press, Chicago 37, Illinois. $9.50. (Reviewed by* H. M. BRIGGS, *Brookings, South Dakota.)*

The author has made quite a complete analysis of the history that led to passage of the Taylor Grazing Act in 1934. This Act empowered the Bureau of Land Management of the Department of Interior to handle the "vacant, unappropriated and reserved lands . . . of the public domain." The author describes the three major provisions of the Act as: (1) To stop injury to public grazing lands by preventing over grazing; (2) to provide for orderly use, improvement and development, and (3) to stabilize the livestock industry dependent upon public range.

The first four chapters of the book are devoted to general background. The next seven chapters are specific analyses of the grazing districts that have been set up by and supervised by the Bureau of Land Management in Wyoming. Each major geographic area, usually a major plain or basin, is discussed in detail. The exact pattern of organization followed in each district, the general and specific problems that have been encountered, and the author's appraisal of the effectiveness of the program in specific locations is clearly and effectively presented. The maps of the various regions and the pattern of land ownership are very helpful in explaining the situation that exists and in laying background as to how problems might be better handled in the future.

It is the special emphasis directed to specific localities that gives this book its unique character and greatest usefulness to the student of range problems. The author

has studied specifics carefully enough so that he does not paint generalities with the "broad brush" so common with those that know less about the true problems and what has or has not been done towards their solution.

The final chapter entitled "Findings and Recommendations" deserves special comment. The chapter opens with just those; the remainder expands the position the author has taken. The author admits a bias towards a stronger program of management for public lands and favors a program more nearly akin to what is now in existence under the Forest Service than under the Bureau of Land Management. His suggestions for improving management of lands under the Bureau are: (1) Improve range management practices, (2) simplify land tenure patterns when feasible, (3) consolidate land ownership when possible, (4) intensify range inspection by competent supervisors, (5) raise range fees to a level more comparable to private rentals, (6) reorganize range use patterns for more judicious use of range forage, and (7) develop a long-range program for the public domain. The author feels the current program is neither designed for temporary use nor for long-time continued use.

A special recognition is given the need for the development of a long-time research program that will find from whence we came, where we are, and where we should be heading in range improvement on the public owned lands. This should merit the special attention of ranchers, congressmen, supervisors, professional workers, and all interested in an improved utilization of vast acreages of arid and semi-arid land. As the author ably points out, the problems of the utilization of the lands under the jurisdiction of the Taylor Grazing Act are not well understood. His discussion of political influence unquestionably will arouse disagreement but he has faced the issue forthrightly and presented his views, evaluations, and recommendations for change. He has achieved this goal of explaining the problems of public lands so others may have improved insight without making such an exhaustive study as he has made.

Water and Agriculture. *Editor:* ROY D. HOCKENSMITH. *206 pp., 17 contributors, illus., refs., index, 1960. American Association for the Advancement of Science, 1515 Massachusetts Avenue, N. W., Washington, D. C. $5.00. (Reviewed by* ERNEST D. WALKER, *Urbana, Illinois.)*

At the 1958 meeting of Section O (Agriculture) of the American Association for the Advancement of Science, held in Washington, D. C., a symposium, "Water and Agriculture," was presented. The program was cosponsored by several technical societies, including the *Soil Conservation Society of America.* The papers presented have been brought together in this attractive volume under the editorship of Roy Hockensmith, Director, Soil Survey Operations, Soil Conservation Service, who served as chairman of Section O (AAAS) in 1958.

In Part I, "Water for the Future," appear the papers, "Water Resource Planning and Development in Agriculture" by Edward A. Ackerman; "Legal Aspects of Water Use in Agriculture" by Clarence A. Davis; "Significance of Small Watershed Programs to American Agriculture" by Carl B. Brown; and "Water Management, Agriculture, and Groundwater Supplies" by R. L. Nace. The predicted rapid increase in population to a possible 330 million by the year 2000 with the consequent need for greatly increased agricultural production is noted. Competition for water for domestic, industrial, and military uses will be keen, to the possible detriment of agriculture. Effective use and conservation of water on farms will greatly influence the adequacy of our water resources.

The small watershed program is hailed as a valuable vehicle for developing community cooperation in resource improvement among rural people. This program is also regarded as an effective medium at the grass roots level for welding the interests and efforts of rural and urban people and thereby helping to accomplish resource development. Various factors affecting the legality of water usage are pointed out including priority of use, State control, Federal encroachment, and enforced limitation on use of ground water. Legal problems connected with weather modification by cloud seeding or other means are on the horizon.

Part II, "Water Sources," contains contributions as follows: "Factors That Affect the Water Cycle" by William C. Ackermann; "Effects of Weather Modification on Water Supplies" by Howard T. Orville; "Use of Climatic Data in Guiding Water Management of the Farm" by C. H. M. van Bavel; and "Precipitation Measuring and Analysis as an Aid to Agriculture" by Gerald I. Barger.

The water cycle and factors affecting it are discussed. It is primarily nature's show but man has effected some changes, one of the greatest impacts being the impoundment of water behind dams. Weather modification is a further possibility although to date results have not been statistically significant. Climatic data including long time records of precipitation can aid in obtaining efficient water management and in evaluating crop prospects.

Part III, "Water Planning and Use," includes: "Relations Between Soil Conservation Practices and Availability of Water" by Cecil Wadleigh; "Increasing Water Yields by Forest Management" by Herbert C. Storey; "Interdependence of Upstream and Downstream

Water Management" by Wayne D. Criddle; and "Views of Water Users on Federal Reclamation Projects" by William I. Palmer.

Several ways in which soil conservation practices, including sound forest management, may affect and increase the soil moisture reservoir are pointed out. A strong case is made for the necessity of cooperation between upstream and downstream programs with examples to show the beneficial results. A brief history of the federal land reclamation program includes reactions of water users. These indicate the need for a national water policy and equitable application of the "ground rules" in all projects of the Bureau of Reclamation.

Included in Part IV, which deals with "Water Control," are the following topics: "Agricultural Drainage: A Continuing Challenge" by T. W. Edminster; "Control of Aquatic and Bank Vegetation and Phreatophytes" by F. L. Timmons and D. L. Klingman; "Suppressing Evaporation from Water Surfaces" by G. Earl Harbeck, Jr.; and "Energy Balance Approach to Evapotranspiration from Crops" by C. B. Tanner.

Despite a history of agricultural drainage running back several hundred years much additional information is still needed. Further research is advocated and several areas are suggested. Loss of water to aquatic and bank growth, running in some cases as high as 3 to 5 acre-feet a year, is reported. Mechanical and chemical methods of control are given but further research is recommended. Lessening of water loss by evaporation from pond and lake surfaces by use of a mono-molecular film is indicated as promising. Wave action is still a problem. The energy balance method is put forth as a satisfactory means of measuring evapotranspiration from crops.

Forage Management in the North Central Area. *By* DALE SMITH. *154 pp., illus., refs., index, 1960. Wm. C. Brown Company, 135 South Locust, Dubuque, Iowa. $3.25. (Reviewed by* A. B. FOSTER, *Washington, D. C.*

This book contains 21 chapters of information on what to do and how to do it in the production of forages in the Cornbelt and Eastern Plains States. The area includes the states of Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas.

The book is based on the forage management course given at the University of Wisconsin by Dr. L. F. Graber, written in mimeographed outline in 1947 by the author and since then revised and expanded to keep up with the new research and developments in forage management.

The material is presented more or less in outline form and attempts to emphasize the application of the principles of plant physiology to the management of forage species predominant in the North Central area.

The author begins with a discussion of forages in the North Central area. He then follows with a discussion of seeding and establishing legumes and grasses, winter survival and management relating to survival, plant nutrition and growth. This is followed by individual chapters on alfalfa, red clover, Ladino clover, birdsfoot trefoil, sweet clover, green manure varieties, producing legume and grass seed, Kentucky bluegrass, bromegrass, timothy, orchardgrass, and Reed canarygrass. Two chapters on pasture renovation and pasture management complete the book.

The book is complete with valuable tables, charts, and graphs. Information is concise and to the point. It should be a valuable reference to field men and to vocational agriculture teachers.

Food for America's Future. *By various authors. 167 pp., 1960. McGraw-Hill Book Company, 330 West Forty-second Street, New York 36. $3.95. (Reviewed by* BEN O. OSBORN, *Washington, D. C.)*

If anyone has any doubt that America will be able to feed its growing population in the future, this little book is designed to allay his fears. It is a conscious and emphatic rebuttal of the philosophy of alarm, written and published under the auspices of the Ethyl Corporation.

Twelve prominent men in the American scientific and industrial world responded to the invitation to tell the story of America's capacity to produce. Their testimony is convincing.

Appropriately, the opening chapters deal with our soil resources and our advancing agricultural technology —the dual foundations of agricultural production. Dr. Firman A. Bear of Rutgers University and Byron T. Shaw, Administrator of the Agricultural Research Service, treat these subjects with unique competence.

New horizons in education and management are sketched by Clifford M. Hardin of the University of Nebraska and Herrell F. DeGraff of Cornell University. Other authors discussing such topics as chemicals, machinery, energy, electricity, etc., are chief executives of General Motors, Shell Chemical, Phillips Petroleum, Allis-Chalmers, Standard Oil, General Electric, General Foods, and the American Farm Bureau Federation.

The tenor of their composite story is obvious. While few would challenge the conclusion that America can look forward to a continued era of abundance, it must be pointed out that most of the authors seem to take our natural resources for granted. We might have expected the spokesmen for these companies, some of which have been generous supporters of conservation programs, to give more consideration to resource conservation as a facet of the new technology on which our future depends.

Current Literature Briefs

Land Use

Suburban Development Districts. *Marion Clawson.* 13 pp., illus. 1960. Reprint No. 20. Resources for the Future, 1775 Massachusetts Avenue, Washington 6, D. C.

In this paper a new form of institution is suggested, with very broad legal and economic powers, to operate only during development period. (Single copies free)

Another reprint (single copy free) available from the Resources for the Future organization:

Changing Patterns of Land Use in the West. Marion Clawson. 12 pp., 1960. Reprint No. 18.

California Public Outdoor Recreation Plan, Part II. 204 pp., illus., 10 x 12¼ in., 1960. Documents Section, State Printing Division, Sacramento, California. $2.00.

This report sets forth in detail with supporting maps, charts, tables, and graphs the nature and scope of California's recreation problems. It shows current demands and future requirements; it catalogs the recreational facilities and areas now available and indicates the quantity of land that has recreation potential.

Part I of this report was noted on page 32, Vol. 16, No. 1 of the JOURNAL. The cost is $2.00.

Range, Its Nature and Use. *Alex Johnson, et al.* 40 pp., illus., 1960. Publication 146. Department of Lands and Forests, Natural Resources Building, Edmonton, Alberta, Canada.

Outdoor Recreation Resources Review Commission-Progress Report. 85 pp., 1961. Outdoor Recreation Rsources Review Commission, Washington, D. C. (Single copies free)

This publication is the text of a report presented by Laurance S. Rockefeller, Commission chairman, to President Kennedy and the 87th Congress in accordance with the provisions of Public Law 85-470.

The task of the Commission is to determine (a) the recreation needs and desires of the American people now, and what they will be in the years 1976 and 2000, (b) what recreation resources are available to fill those needs, and (c) what policies and programs should be recommended to insure that the needs of the present and future are adequately and efficiently met.

This report contains short descriptions of the studies which the Commission is carrying out to fulfill the task assigned to it by Congress. It also describes the Commission's organization, its basic approach, and its plans for completing its work.

Water

Artificial Ground-Water Recharge at Peoria, Illinois. *Max Suter* and *Robert Harmeson.* 48 pp., diagrams, refs., 1960. Bulletin 48. Illinois State Water Survey, Urbana, Illinois.

Through nine years of research, Illinois Water Survey scientists developed a successful pit method of artificial recharge for the heavily-used underground water supplies at Peoria. This method now contributes substantially to maintaining the water table in that area. This publication describes this research, the types of recharge pits constructed and the operating techniques involved. Operating records show pit capacity and cost information.

Local Administration of Water Control in a Number of European Countries. *F. Hellinga.* 46 pp., 1960. International Institute for Land Reclamation and Improvement, P.O.B. 45, Wageningen, The Netherlands. $1.00.

Saline Water Conservation. 246 pp., 1960. American Chemical Society, 1155 Sixteenth Street, N.W., Washington 6, D. C. $5.85.

This book contains the papers given before the 1960 Symposium on Saline Water Conversion sponsored by the American Chemical Society. The most recent projects and conclusions of research teams in universities, industry and government are presented.

Annotated Bibliography and Comments on the Estimation of Flood Peaks from Small Watersheds. *Brian M. Reich.* mimeo., 1960. Civil Engineering Department, Colorado State University, Fort Collins.

Interpretation and Current Status of Ground Water Rights. *Arthur M. Piper.* 10 pp., refs., 1960. Geological Survey Circular 432. U. S. Department of the Interior, Washington 25, D. C. (Single copies free)

Progress Report on Use of Water by Riparian Vegetation at Cottonwood Wash in Arizona. 11 pp., 1960. Geological Survey Circular 434. U. S. Department of the Interior, Washington 25, D. C. (Single copies free)

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Projections of Water Requirements in the Economics of Water Policy. *S. V. Ciriacy-Wantrup.* 24 pp., mimeo., 1960. Giannini Foundation Paper No. 193. Agricultural Experiment Station, University of California, Berkeley.

This paper was presented by the author before the Western Resources Conference held at Boulder, Colorado.

Ohio Water Management Conference Proceedings. 154 pp., 1960. Ohio Department of Natural Resources, 1562 W. First Avenue, Columbus 12, Ohio. (single copies free)

This report contains presentations made at the conference sponsored by the Ohio Water Commission December 8-9, 1960, and also includes reviews of present agency programs in water as well as a series of recommendations concerning water legislation.

Michigan Water Use and Development Problems. *A. Allan Schmid.* 30 pp., refs., 1961. Bulletin 230. Agricultural Experiment Station, Michigan State University, East Lansing. (Single copies free)

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Earth Manual. 751 pp., illus., 4½x7½ in., index, 1960. U. S. Government Printing Office, Washington 25, D. C. $3.75.

This guide to the use of soils as foundations and as construction materials for hydraulic structures replaces a tentative edition prepared by the U. S. Bureau of Reclamation in 1951.

Concrete Pipe for Irrigation in Hawaii. *Bessel D. van't Woudt.* 62 pp., illus., refs., 1959. Circular 57. Hawaii Agricultural Experiment Station, University of Hawaii, Honolulu.

Measurement of Water Over Silted-In Weirs. *G. L. Corey* and *Robert McFall.* 16 pp., illus., 1960. Research Bulletin No. 47. Agricultural Experiment Station, University of Idaho, Moscow.

Logging Road Handbook: The Effect of Road Design on Hauling Costs. *James Byrne, Roger Nelson* and *Paul Googins.* 65 pp., illus., bibl., 1960. Agriculture Handbook No. 183. Forest Service, U. S. Department of Agriculture, Washington 25, D. C.

Access Through the Ice in Farm Ponds for Fire Protection. *E. C. Schneider.* 8 pp., mimeo., illus., 1959. Agricultural Experiment Station, University of Vermont, Burlington.

Forestry

Second Growth Western White Pine Stands. *Richard F. Watt.* 60 pp., illus, index, 1960. Technical Bulletin No. 1226. U. S. Government Printing Office, Washington 25, D. C. $0.25.

This bulletin is the result of information gathered on permanent test plots. Discussed in detail are site index and species changes, normality percentage trends and mortality.

Forest and Range Fire Problems of the Missouri Ozarks. *John S. Crosby.* 53 pp., illus., 1960 Central States Forest Experiment Station, 111 Old Federal Building, Columbus 15, Ohio.

Southern Region Report: U. S. Forest Service. 16 pp., illus., 1960. U. S. Forest Service, Southern Region, 50 Seventh Street, N.E., Atlanta 23, Georgia.

How To Fertilize Trees and Measure Response. *Stanley Gessel, Kenneth Turnbull* and *F. Todd Tremblay.* 67 pp., illus., refs., 1960. National Plant Food Institute, 1700 K Street, N.W., Washington 6, D. C. $0.50.

The Brush Problem on California Livestock Ranges. 30 pp. illus., 1960. California Division of Forestry, Sacramento, California.

Management and Inventory of Southern Hardwoods. *John Putnam, George Furnival,* and *J. S. McKnight.* 102 pp., illus., 1960. Agricultural Handbook No. 181. U. S. Government Printing Office, Washington 25, D. C. $0.55.

Plants

Vetches of the United States. *F. J. Herman.* 84 pp., illus., index 1960. Agriculture Handbook No. 168. U.S. Government Printing Office, Washington 25, D. C. $0.40.

This booklet contains an individual description and line drawing of each of the native, naturalized, and cultivated vetches, one of the most economically important genera of legumes.

Summary of Weed Control on National Wildlife Refuges. Compiled by W. B. Stiles, 63 pp., mimeo., index, 1959. Bureau of Sport Fisheries and Wildlife, U. S. Department of the Interior, Washington 25, D. C.

Phreatophytes. *T. W. Robinson.* 84 pp., illus., refs., 1958. U. S. Geological Survey Water-Supply Paper No. 1423. U. S. Government Printing Office, Washington 25, D. C. $0.40.

Phreatophytes are plants that depend for their water supply upon ground water that lies within reach of their roots. This paper includes a list of all plants in the desert areas of the Western United States that have been identified as phreatophytes, together with the available data concerning their occurence, habits, and annual consumption of ground water.

A Simple Way to Test Your Grain and Hay for Moisture. *Dale Hull* and *Larry Van Fossen.* 4 pp., illus., 1960. Iowa Extension Service, Morrill Hall, Iowa State University, Ames. Single copies free)

This brief bulletin describes the Dexter modified oil-distillation method for determination of moisture content in hay or grain. It can be carried out with equipment normally found in the home.

General Interest

The Nature and Fate of Chemicals Applied to Soils, Plants and Animals. 221 pp., refs., paper cover, 8x10¼ in., 1960. Agricultural Research Service, U. S. Dept. of Agriculture, Washington 25, D. C.

This pubication contains the papers presented at a symposium on agricultural chemicals, sponsored by the Agricultural Research Service, U. S. Department of Agriculture, and held at Beltsville, Maryland, April 27-29, 1960. Federal research and regulatory agencies, State agricultural experiment stations, and chemical companies participated in the meeting.

The 22 papers contained in the book are divided into three sections, "Responsibility of the Federal Agencies and Industry," "Progress and Problems," and "Fate of Chemicals."

The Stories Behind the Organization of the National Wildlife Federation. *Carl D. Shoemaker.* 60 pp., 1960. Carl Shoemaker, 4920 Earlston Drive N.W., Washington 16, D. C. $1.00.

Proceedings of the 1959 Wildland Research Conference. Henry J. Vaux, Editor. 97 pp., 8½x11 in., 1960. University of California, Berkeley.

The 10 papers, including comments and discussions, contained in this publication were given at the California Wildland Research Center Conference held October 19-20, 1959, at Yosemite Park.

Notes from the Field

Depth and Spacing of Parallel Drain Tile Laterals

KURT NATHAN

DETERMINATION of proper depth and spacing for parallel drain tile laterals has long been a perplexing problem to field engineers. The fact that installation is usually based on the judgment of the drainage engineer presents a difficult problem for the less-experienced field man. To determine whether some of the methods for depth and spacing determination of tile proposed in the literature might be made more useful to such men was the purpose of the study reported here.

Eleven suitable tile-drained sites in Monmouth County, New Jersey, were selected and the physical properties of the soils were studied. The depth and spacing of the laterals, as required by various methods, were determined and the results compared with actual depth and spacing as indicated by the judgment of field man and farmer. The methods of Neal (4), Donnan (3), Slater (5), Walker (8), and Visser (7) were compared. In addition, results were checked with drainage tables (1) (2).

Slater's method is actually an extension of Donnan's equation and facilitates practical field assessment. Walker's method did not appear to be applicable to local soils.

Certain measurements and assumptions had to be made and these were as follows: For Neal's method, the upper plastic limit (liquid limit) of the subsoils studied was established by duplicate determinations, and the clay content of the subsoils was determined with duplicate samples by the Bouyoucos hydrometer method. For the Donnan-Slater method, the hydraulic conductivity (a measure of permeability) of the subsoils was established by the visual inspection method, slightly modified, suggested by Uhland and O'Neal (6).

A hole about 2½ feet in diameter and 2½ to 3 feet deep was dug for each sample and the hydraulic conductivity of the subsoil was judged by evaluating (a) type of structure, (b) relative length of horizontal and vertical axes of structural aggregates, (c) amount and direction of overlap of structural aggregates, (d) grade (stability) of structural aggregates, (e) comparative ease and direction of natural breakage, (f) size and number of visible pores, (g) cracks and channels visible under a hand lens, (h) compaction, (i) size and shape of sand grains, and (j) mottling.

The average percolation rate for each permeability class was assigned on the basis of (a), (b), and (c) above and a weighted adjustment was added to or subtracted from the average rate on the basis of the other characteristics, depending on whether these would tend to increase or decrease the percolation rate.

A score sheet was used for each sample. A permeability class was obtained by using Table 5 and Figure 8 in S.C.S. Technical Publication 101 (6) and the percolation rate was determined from the following:

Permeability Class	*Percolation Rate, inches per hour(iph)*
1 Very slow	Less than 0.05
2 Slow	0.05— 0.20
3 Moderately slow	0.20— 0.80
4 Moderate	0.80— 2.50
5 Moderately rapid	2.50— 5.00
6 Rapid	5.00—10.00
7 Very rapid	10.00+

Also, for the Donnan-Slater and Visser methods the actual depths were used, as outlet conditions often govern the depth at which tile is laid. An impervious layer 2 feet below the tile and a recession rate of 0.01 inches per hour were assumed. It was also assumed to be desirable that the water table should not rise above 1 foot below the ground surface. These assumptions are suggested by Slater (5).

The results of the study are given in table 1. The table shows that fair agreement was found between the Visser and Donnan-Slater methods and the actual installation in 8 out of 10 cases.

Although the spacings obtained by these methods are still based on the judgment of the field man, it should be easier for the less-experienced man to evaluate 10 separate physical properties on a score sheet than to make just one judgment as to drainability of a field.

The Visser and Donnan-Slater methods seem to be more helpful than the others. Only on sites 2-A and 3-A was there a real difference between the actual and the computed spacings.

While a spacing of about 100 feet on site 2-A would have been sufficient in

TABLE 1

Spacings and Depth of Parallel Drain Laterals as Determined by Various Methods, Monmouth County, N. J., 1956

	Spacing and Depth in Feet							
Field	*Actual*	*Visser's*	*Donnan-Slater's*	*Neal's by Percent of Clay*	*Neal's by Liquid Limit*	*Armco Table*	*ASAE Table*	*Soil Type*
1-C	80 3.0	84 3	92 3	140 4.6	250 5.4	100-150 3-4	100-300	Monmouth Sandy Loam
1-B	80 3.0	78 3	88 3	50 3.3	50 3.2	85-100 3-4	100± **	Donlonton Loam
2-E	50 2.7	53 2.7	58 2.7	19 * 2.3	13 * 2.1	85-100 3-4	100± **	Monmouth Loam
7-A	40 2.5	51 2.5	51 2.5	35 2.7	25 2.6	100-150 3-4	100-300	Woodstown Sandy Loam
4-A	100 3.0-3.5	97 3.25	106 3.25	60 3.4	60 3.3	100-150 3-4	100-300	Donlonton Sandy Loam
2-A-8120	50 3.5	100 3.5	108 3.5	48 3.2	42 3.2	85-100 3-4	100± **	Donlonton Loam
2-A-8123	50 3.5	95 3.5	103 3.5	68 3.6	65 3.5	100-150 3-4	100-300	Donlonton Sandy Loam
5-A	100 3.0	80 3	88 3	100 4.0	68 3.5	75-85 3-4	60-100	Fallsington Silt Loam
2-D	60 2.7-3.0	70 3	75 2.8	19 * 2.3	11 * 1.9	85-100 3-4	100± **	Collington Loam
1-A	80 3.0	78 3	88 3	110 4.2	70 3.6	85-100 3-4	100± **	Collington Loam
3-A	100 2.7-3.0	28 2.85	29 2.85	20 * 2.4	13 * 2.1	100-150 3-4	100-300	Donlonton Sandy Loam

*Exceed scales of graphs. Calculated values
**Loam considered intermediate between silt loam and sandy loam

the judgment of the field man, the farmer insisted on closer spacing as the field is being intensively cropped with potatoes. In contrast, site 3-A is in general crops not too sensitive to water and planted later in the season. The farmer wanted to have a minimum investment in tile.

The overall drainage results on all sites studied are very satisfactory.

Sample Calculations—Site 4-A
Determination of Percolation Rate

a. Type of structure: Fragmental.
b. Relative length of horizontal and vertical axes of structural aggregates: Vertical slightly larger.
c. Amount and direction of overlap of structural aggregates: Oblique.

Permeability class from Table 5, SCS, TP 101 (6) on the basis of these three observations: Slightly more than moderate.

Percolation rate for moderate permeability: 0.8 to 2.5 inches per hour; average 1.65 inches per hour. Adjust this to 1.70 inches per hour since the vertical axes of structural aggregates are slightly larger than the horizontal axes.

d. Grade: Strong. Adjust to 1.80.
e. Comparative ease and direction of natural breakage: Easy breakage in all directions. No adjustments.
f. Size and number of visible pores: Some pores visible, large. Adjust to 1.90.
g. Cracks and channels visible under a hand lens: Some visible. Adjust to 2.00.
h. Compaction: Weak (to moderate). Adjust to 2.10.
i. Size and shape of sand grains: Large, angular, considerable number. Adjust to 2.00.
j. Mottling: None. No adjustment. Final percolation rate 2.00 inches per hour.

Slater's Equation

$$s^2 = \frac{4p\ (b^2 - a^2)}{v}$$

where s = distance between laterals, feet.
p = permeability (hydraulic conductivity), inches per hour
b = distance from impermeable layer to the highest elevation of the water table, feet.
a = distance from impermeable layer to the tile, feet.
v = recession rate of the water table, inches per hour.

$p = 2.00$ iph. $a = 2.0$ ft. $v = 0.01$ iph.
$b = 4.25$ ft.

$$s^2 = \frac{(4)\ (2)\ (18 - 4)}{0.01} = 11{,}200$$

$s = 106$ ft.
d = actual depth = 3.25 ft.

Visser's Method

$$\frac{k}{s} = \frac{2.00}{0.01} = 200$$

where k = permeability (hydraulic conductivity), inches per hour (Donnan-Slater's p) = 2.00
s = rainfall removed, inches per hour (Donnan-Slater's v) = 0.01
(identical units must be used in the numerators and denominators of all ratios. While Visser uses meters and meters per day, feet and inches per hour may be used without conversion to obtain the same ratios.)

$$\frac{d}{m} = \frac{2.0}{2.25} = 0.89$$

where d = distance of tile above impermeable layer, ft. (Donnan-Slater's a) = 2.0
m = hydraulic head, ft. (Donnan-Slater's b-a) = 4.25 - 2.0

$\frac{1}{m} = 43$ from nomograph in the reference (7).

where 1 = tile spacing ft.
m (has been defined above) = 2.25
$1 = 43\ m = (43)\ (2.25) \cong 97$ ft.
d = actual depth = 3.25 ft.

REFERENCES CITED

1. American Society of Agricultural Engineers. 1960. *Agricultural Engineers Yearbook*. St. Joseph, Michigan. Seventh Edition. 400 pp., illus., p. 141.
2. Armco Drainage & Metal Products, Inc. 1955. *Handbook of Drainage and Construction Products*. Middletown, Ohio. 579 pp., illus., p. 337.
3. Donnan, W. M. 1947. *Model tests of a tile spacing formula*. Soil Sci. Soc. of Am. Proc. 1946. 11:131-136.
4. Neal, J. H. 1934. *Proper spacing and depth of tile drains determined by the physical properties of the soil*. Tech. Bul. 101. University of Minnesota, St. Paul. 62 pp., illus.
5. Slater, C. W. 1950. *The depth and spacing of tile drains*. Agr. Eng. 31 (9): 448-450. September.
6. Uhland, R. E. and A. M. O'Neal. 1951. *Soil permeability determinations for use in soil and water conservation*. U. S. Dept. of Agr., SCS-TP-101. Washington, D. C. 33 pp., illus.
7 Visser, W. C. 1954. *Tile drainage in the Netherlands*. Netherlands Journal of Agricultural Science. 2:69-87. May.
8. Walker, P. 1952. *Depth and spacing for drain laterals as computed from core-sample permeability measurements*. Agr. Eng. 33 (2):71-73, February.

Kurt Nathan is an associate professor of agricultural engineering, Rutgers—The State University, New Brunswick, New Jersey. *The author expresses his appreciation to Neal Munch of the Soil Conservation Service, Freehold, New Jersey, for his cooperation in the field study reported in this article.*

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WATER YIELDS FROM SMALL OZARK WATERSHEDS

RONALD Z. WHIPKEY

AMPLE WATER at the right time is important to farmers, ranchers, and foresters—everywhere. The moisture situation is especially critical in the Missouri Ozarks where rainfall is erratic at best in the hot growing months. This spotty rainfall pattern, coupled with soils that are rocky and "thin," and generally incapable of holding large amounts of moisture for plant use, leads to frequent summer droughts in the Ozarks.

Irrigation has been proposed as one way of using the available water for increasing productivity from Ozark farm and forest soils (1). This practice has caught on slowly, however, for irrigation and water-supply systems are costly. In addition, success depends somewhat on adequate rainfall and streamflow for recharge of the water supply.

To learn something of water yields from small Ozark watersheds and their capabilities as water supply sources, 7 years' precipitation and streamflow records from three small Ozark watersheds were studied (3). By using standard hydrologic techniques, total annual flow, seasonal flow, low flow, baseflow, and stormflow on the watersheds were analyzed.

Flow from these three small watersheds was undependable for direct water supply especially during the growing season when water is most acutely needed.

The Watersheds

The three watersheds were selected because of their representative sizes and proximity to one another. Soil series (Clarksville loam) and surface geologic formation (Roubidoux dolomite) were the same for all three areas. The Clarksville soils have good infiltration and are well drained, but are usually stony in the hilly

areas. The three drainages differed in land-use history and cover types, but no comparisons were made on the basis of land use or vegetative cover.

The smallest area, watershed A (0.6 square mile), lies in the upper reaches of a larger watershed and has fairly level terrain. Soil of watershed A is relatively stone-free and the entire watershed is cropped and pastured. The second area, watershed B (6.4 square miles), has stony surface soil and rolling to rugged terrain. Approximately 35 percent of this watershed is in oak-hickory forest and 65 percent in pasture and cultivated crops. The third and largest area, watershed C (14 square miles), has stony surface soil and rugged terrain. Approximately 60 percent of this watershed is in oak-hickory forest, and the balance is in pasture and cultivated crops.

The principal cultivated crops on the three watersheds are corn and sorghum on the bottomland and corn, wheat, oats, and clover on the uplands. The farmers on watershed A rotate their crops and keep the rougher land in tame pasture. The most important native pasture grass is little bluestem, and the tame grasses are orchard grass and fescue.

The timber on watersheds B and C is predominantly blackjack, post, white, and black oak. Trees are generally small and widely spaced, and timber quality is poor to fair. With few exceptions, the steeper slopes are in trees or brush. Generally, this is because the soil on the slopes is extremely stony and the broken terrain is difficult to farm.

Water Yields

Average annual precipitation on the three areas was 38 inches for the period 1948 through 1955 (figure 1). This is near the "normal" for this part of Missouri, but the yearly precipitation ranged from 18 to 65 inches. About 60 percent of this fell during the growing season when evapotranspiration was highest.

However, yearly runoff resulting from this precipitation was not uniform on all three areas. The average yearly flow for watershed A was 10 inches, and for B and C about 13 inches (figure 1). The annual streamflow from the largest watersheds corresponded to the normal average for this section of Missouri (2).

Distribution and timing of flow are important in use of streamflow, especially during the growing season when farm ponds and reservoirs may become depleted through heavy water use and evaporation. Even though 60 percent of the precipitation fell during the growing season, only 40 percent of the annual flow (from all three watersheds) occurred during that season. This means that enough water should be stored during the wet, dormant season to offset streamflow deficiencies during the growing season.

Equally as important as seasonal flow is the nature and origin of the flow making up annual yield. If a large part of the annual flow comes from stormflow (that occurring during or shortly after precipitation) then the streams will be dry much of the year. However, if there is a good balance between stormflow and baseflow (that coming from groundwater storage), the streamflow will be sustained throughout much of the year.

To learn something of this, each hydrograph for the 7 years was analyzed and baseflow, stormflow, and rates of baseflow depletion were computed. Flow frequency curves were constructed. It was then evident that watersheds B and C have far more unit-storage capacity for groundwater than the smaller watershed. Annual stormflow from all three watersheds was only 3 inches compared to 6 from the largest watersheds (figure 1). In addition, during the driest growing seasons baseflow from the two larger watersheds greatly exceeded stormflow, while no measurable flow of any kind occurred from the smallest watershed.

Groundwater depletion rates show why this happened. It took 45 to 55 days for the streams of the largest watersheds to deplete the groundwater in storage, while the stream of watershed A would run dry in less than 20 days.

Although the streams draining watersheds B and C were never dry from 1948 to 1955, minimum flows were as low as 50 to 100 gallons per hour per square mile. These lows occurred during a 10-month period when only 12 inches of precipitation fell. In the same period no flow was recorded at the gauge of watershed A. This suggests the *minimum* summer flow that may occur from drainages in the Ozarks during prolonged dry periods. During such periods, farm water demands, such as for irrigation, would require that these flows be supplemented with water from deep, underground sources or surface reservoirs. And minimum flows, such as those above, would do little to recharge reservoirs already depleted by heavy use and evaporation.

Conclusions

From this study it was learned that even though total precipitation was similar, less water (in unit flow) was available annually from a watershed less than 1 square mile in area than from two watersheds 6 and 14 square miles in area. Furthermore, flow from the smallest watershed was poorly sustained. The largest watersheds had some flow at all times—but minimum flow during the growing season was not enough for water supply.

Just what does this mean? First, the differences in streamflow between the smallest and the two largest watersheds are largely attributable to soils, size, and topography. The soil of watershed A, while of the same series as B and C, is deeper and relatively stonefree. More of the total infiltration may be retained as

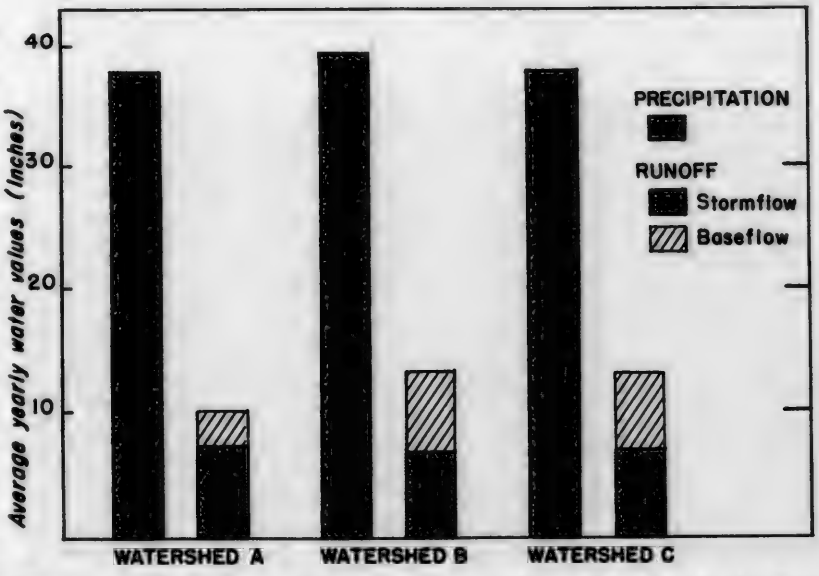

Figure 1. Yearly average precipitation, runoff, stormflow, and baseflow for the three watersheds, October 1948 to September 1955. Total runoff is composed of stormflow and baseflow.

soil moisture, with less going into groundwater storage. On the other hand, more of the infiltrated water went into groundwater storage and less into soil moisture in the thinly mantled, rocky soil of watersheds B and C. This can be seen from the baseflow that occurred even in the driest periods. The smaller size and upstream location of watershed A as compared with B and C may also have had something to do with the baseflow. Some gravitational water from small watersheds, such as A, may quickly seep to groundwater tables below the stream channel and bypass the stream-gauging station.

Second, flow quantities from small watershed streams in the Ozarks are undependable for direct use. At the present, watershed residents must resort to artificial storage if their streams are to be used for irrigation or other purposes. Of particular importance are the low flows during the growing season indicating that water for use in critically dry periods should be stored during the late winter.

REFERENCES CITED

1. Fletcher, P. W., and R. E. McDermott. 1958. *An Ozark valley—year 2000.* Missouri Wildlife 20: 3-5, 14-15. April.
2. Langbein, W. B., and others. 1949. *Annual runoff in the United States.* U. S. Geol. Survey Cir. 52. Washington, D. C. 14 pp. illus.
3. Whipkey, R. Z., and P. W. Fletcher. 1959. *Precipitation and runoff from three small watersheds in the Missouri Ozarks.* Mo. Agr. Expt. Sta. Res. Bul. 692. Columbia. 28 pp., illus.

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Saving Water Through Chemical Brush Control

ROBERT A. MERRIAM

INCREASED FORAGE . . . improved timber stands . . . better crops—these can be the results of the proper use of plant-control chemicals. Can increased usable water yield be added to this list? A partial answer to this question may be obtained from a brush-control study on the San Dimas Experimental Forest.[1]

The brush-covered mountain watersheds above southern California's South Coastal Basin are the greatest single source of water for the highly developed urban, industrial, and agricultural economy of this area. Importing water into the area is necessary to sustain the present and future economy, but local mountain water will always be the cheapest, and in some places the only available supply. Practical methods for economically increasing water yield from these mountains are urgently needed.

Hydrologic studies relating to the management of brush-covered watersheds in the semiarid southwest have been conducted on the experimental forest since 1933. Soil-plant-water studies have shown that the amount and distribution of rainfall, depth and physical characteristics of soil, and depth of rooting of vegetation all influence water yield. Evaporative losses from bare soil and evapotranspiration from brush, grass, and grass-forb vegetation have been studied (2) (3) (4). The study reported here compared water losses on brush plots before and after spraying with 2,4,5-T.

[1] The San Dimas Experimental Forest is a field unit of the Pacific Southwest Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, maintained in cooperation with the State of California, Division of Forestry. It is located in the San Gabriel Mountains about 35 miles northeast of Los Angeles.

Procedure and Area Description

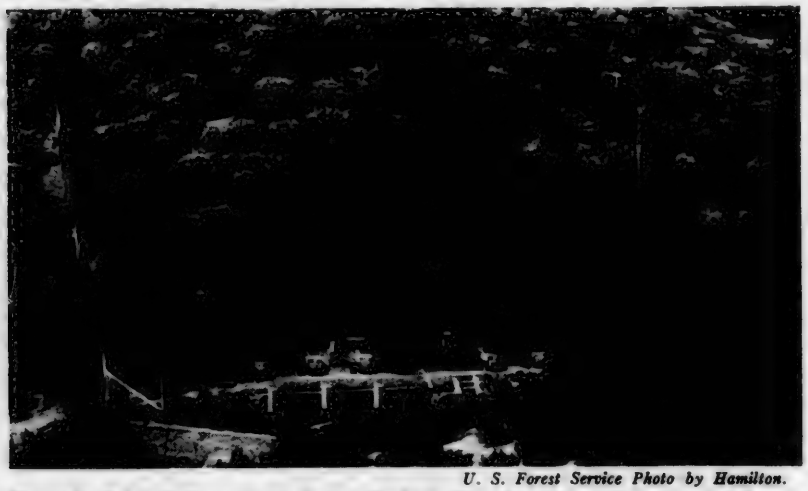
The three 1/40-acre plots used in this study were covered with dense scrub-oak chaparral, 10 to 15 feet high (figure 1). A litter cover from ½ inch to 2 inches deep had built up on the soil surface since the vegetation was last burned in 1919. The soil is a sandy loam, averaging about 12 feet deep, much deeper than most San Gabriel Mountain soils.

During the summer of 1956, some brush on the plots was accidentally defoliated by drifting spray from adjacent plots. A complete kill was therefore planned, and nearly 5 gallons of 2,4,5-T (4 pounds acid equivalent per gallon) in an oil-water emulsion were applied with hand sprayers to an area of less than an acre. The first spray was a heavy dosage applied during the fall, yet follow-up spraying was necessary to attain a complete kill. Dead brush was left standing in place. Rainfall and surface runoff were recorded for each storm. Soil moisture was measured after each storm and at weekly intervals with Colman electrical resistance units (1), distributed through the entire soil profile down to fractured bedrock.

Two year's records, from November 1955 to October 1957, are considered in this report. Rainfall was below the 27-inch average both years for 20.5 inches was recorded the year before spraying and 19.5 inches fell the following year. No surface runoff or percolation of water through the soil below the 12-foot depth occurred either year. Water loss from the plots during this period was limited to evapotranspiration and was determined from changes in soil moisture. Average moisture content through the soil profile was determined in the lower, middle, and upper one-third of the center plot.

Effects of Spraying

The disposition of rainfall during the year following brush treatment (1955-56) was quite in contrast with that of the preceding year (figure 2). More than 18 of the 20.5 inches of 1955-56 rainfall was lost by evapotranspiration during the year. All would probably have been lost had not the drifting spray defoliated some vegetation. After complete spraying, about



U. S. Forest Service Photo by Hamilton.

Figure 1. Rainfall disposition plots at Tanbark Flat, San Dimas Experimental Forest. Three plots on right side of the fenced enclosure were used in this study. Six plots on left were converted to grass in 1952. *Ceanothus crassifolius* shown in bloom.

7 inches was lost, and nearly 13 of the 19.5 inches of rainfall remained in the soil at the end of the summer dry period.

The benefit in ground-water yield of this carryover occurs during subsequent rainy seasons. Less rain is required to wet the soil mantle and start deep percolation below the root zone.

The daily rates of evapotranspiration were widely different before and after phytocide treatment (table 1). After treatment, the rate of loss during the wet season was about half that of the untreated brush. For the dry season, the killed brush area lost only one-third that of the live brush. These differences probably would have been greater had the brush been killed by the first chemical spraying.

TABLE 1

Total and Average Daily Evapotranspiration for Wet and Dry Seasons Before and After 2,4,5-T Treatment of Brush

Season[1]	*Number of days*	*Seasonal*	*Average daily*
		Inches	*Inches*
Brush in Full Foliage—1955-1956			
Wet	184	7.95	0.043
Dry	198	[2]10.29	[2]0.052
Both	382	18.24	0.048
Brush Sprayed With 2,4,5-T—1956-57			
Wet	207	4.99	0.024
Dry	107	1.91	0.018
Both	314	6.90	0.022

[1]1955-56 Wet season—11- 8-55 to 5-10-56
Dry season—5-10-56 to 11-24-56
1956-57 Wet season—11-24-56 to 6-19-17
Dry season—6-19-57 to 10- 4-57

[2]Probably low due to spray drift from adjacent plots.

An impressive amount of water was stored in the soil the first year after chemical brush control. But it must be remembered that this comparison is made on a site that contained dense brush with a good litter cover on deep soil capable of storing large amounts of water. Smaller gains would be expected on shallower soils, on soils with less vegetative and protective litter cover, and in years of less rainfall.

Many factors must be considered in determining the place of plant-control chemicals in increasing water yield. The cost of such control, possible benefits such as increased forage, recreational and other uses of the land, and possible off-site damage by chemical residuals must influence land management decisions. Nevertheless, the 13 inches of extra soil moisture in these sprayed plots is good evidence that plant-control chemicals can increase the yield of usable water on selected sites.

REFERENCES CITED

1. Colman, E. A. and T. M. Hendrix. 1949. *The fiberglass electrical soil moisture instrument.* Soil Sci., 67 (6): 425-438., illus.
2. Rowe, P. B. and E. A. Colman, 1951. *Disposition of rainfall in two mountain areas of California.* U. S. Dept. Agr. Tech. Bul. 1048. Washington, D. C. 84 pp., illus.
3. U. S. Forest Service. 1956. *Forest Research in California Annual Report,* 1955. Calif. Forest and Range Expt. Sta. 92 pp., illus.
4. U. S. Forest Service. 1957. *Forest Research in California Annual Report,* 1956. Calif. Forest and Range Expt. Sta. Berkeley. 66 pp., illus.

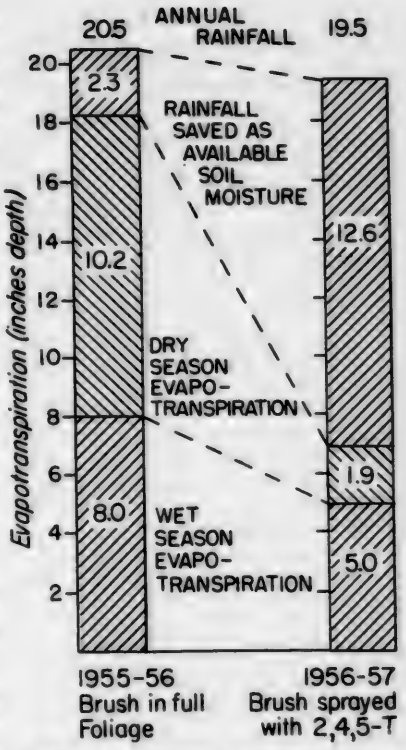


Figure 2. Seasonal evapotranspiration from dense scrub oak chaparral before and after phytocide treatment.

Robert A. Merriam is forester and works in watershed management research at the Pacific Southwest Forest and Range Experiment Station. His headquarters are in Glendora, California.

White Plastic Film Protects Newly Seeded Areas

LEONARD C. JOHNSON

White pigmented translucent polyethylene plastic film placed over newly-seeded grass plots in the fall of 1958 not only protected the soil surface from erosion but also provided very favorable growth conditions for the grass seedings in late fall and early spring.

TO EVALUATE the use of plastic films for protection of newly-seeded areas during the critical period of germination and establishment, a field study was conducted using clear, white, and metallic gray plastic films on seedings of Kentucky bluegrass, smooth bromegrass, tall fescue, and Reed canarygrass. Seedings were made on September 8 and October 1, 1958, and the plastic covers installed the day after seeding. The plastic covers were removed from the first seeding on September 29, October 28, and May 5, and from the second seeding on October 28, November 12, and May 5.

The seedbed was very dry and rather cloddy at the time of the first seeding. Soil moisture in the surface 2 inches was only about 2 percent above the wilting point, and in the 2-4 inch depth only 8 percent above it. At the second seeding, soil conditions were quite favorable; the moisture content was only slightly below field capacity in the surface 2 inches. Data in table 1 show the soil moisture content near the surface on seeding dates and immediately after the plastic films were re-

TABLE 1

Moisture Content (Per Cent by Weight) of Surface Soil at Two Depths on Seeding and Plastic Cover Removal Dates

Seeding and Cover Removal Dates	*No Cover*		*Clear Plastic*		*White Plastic*		*Metallic Plastic*	
	0-2″	2-6″	0-2″	2-6″	0-2″	2-6″	0-2″	2-6″
First Seeding								
Sept. 8[1]	12.3	18.7	—	—	—	—	—	—
Sept. 29[2]	17.3	23.0	14.4	21.9	15.9	21.1	15.5	20.3
Oct. 28[3]	27.4	25.5	19.6	22.3	23.7	25.1	21.9	23.6
Second Seeding								
Oct. 1[1]	22.5	26.8	—	—	—	—	—	—
Oct. 28[2]	28.5	29.3	27.5	28.8	25.0	24.1	26.5	28.3
Nov. 12[3]	19.6	25.3	22.4	25.0	24.5	26.3	25.0	26.5

[1] Seeding date [2] First cover removal date [3] Second cover removal date

TABLE 2

Surface Soil Temperatures[1] Under Three Kinds of Plastic Film Mulch and Air Temperature on Various Dates

Date	Air (at 10" Height)		Clear Plastic		White Plastic		Metallic Plastic	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Sept. 20	52	87	62	106	59	88	56	86
Oct. 3	36	71	52	100	48	80	46	77
Oct. 18	45	75	58	96	54	78	52	77
Nov. 7	31	59	39	74	39	60	34	57
Apr. 16	41	73	57	103	53	81	49	78
Apr. 21	31	51	45	91	45	69	39	65
May 3	58	88	72	110	67	92	64	92

[1] Degrees Fahrenheit

moved in the fall. Some upward movement of soil moisture apparently occurred where the soil surface was covered with a plastic film mulch. No soil moisture measurement was made when the plastic film was removed on May 5.

Temperatures were measured just beneath the soil surface under each of the three kinds of plastic film. On a clear day when the maximum open-air temperature near the ground ranged from 70 to 95° F., surface soil temperature beneath the clear plastic rose to 100 to 110° F. for several hours. This appeared to have a harmful effect on grass seedings. Under the white and metallic plastic films, surface soil temperatures did not fluctuate as widely, nor did they rise to harmful levels. Temperature records from several selected representative days are given in table 2. While metallic plastic was used in this study it can be eliminated from further consideration for this use, as it apparently does not transmit enough light to permit normal plant growth.

Table 3 presents a subjective comparison of the density and quality of the grass seedings in those plots where the plastic film remained on the surface over winter. This evaluation was made in mid-July, 1959, and is based on a visual rating scale on which 0 signifies a bare plot or one having only weeds, and 6 identifies a dense, excellent stand of the seeded grass. Each value is an average of three replicates. No advantage was obtained in seeding establishment by removing the plastic film 3 weeks or 6 weeks after seeding. However, since protection of the freshly-worked surface against erosion throughout the winter and spring seasons is desired, fall removal of the plastic film is not of practical value. By the use of a white pigmented translucent polyethylene film mulch, grasses may be seeded much later in the fall than normal practice would allow. As surface soils are often quite dry in late August and early September, later seedings may be enhanced by better moisture supplies.

Because of the cost of the material and the labor involved in its application, a plastic film mulch could probably be justified only when seeding small, critical-problem areas, such as dam overflow spillways, terrace outlets, sod flumes, and the slopes of earthen dam fills. The film must be fastened down securely around the edges, and it must be weighted or otherwise secured to the surface every few feet to prevent billowing by the wind.

Leonard C. Johnson is a soil scientist with the Soil and Water Conservation Research Division, Agricultural Research Service. His headquarters are in Urbana, Illinois, and the research reported in this article was carried out in cooperation with the Illinois Agricultural Experiment Station.

TABLE 3

Mid-July Visual Rating[1] Comparison of Grass Stands Covered by Plastic Films from Seeding Date Until Early May

Kind of Plastic Cover	September 8 Seeding				October 1 Seeding			
	K[2]	B[3]	R[4]	F[5]	K[2]	B[3]	R[4]	F[5]
None	4.3	4.3	4.3	4.3	2.0	2.7	1.0	1.0
Clear	1.3	1.7	1.3	1.7	1.0	1.0	1.0	1.0
White	5.0	5.0	5.0	4.7	6.0	6.0	6.0	6.0
Metallic	0	0	0	0	0	0	0	0

[1] Scale 0 = failure and 6 = excellent stand
[2] K = Kentucky bluegrass
[3] B = Smooth bromegrass
[4] R = Reed canary grass
[5] F = Tall fescue

AUDIO-VISUAL AIDS

Film: The Big Four. 16mm., 25 min., sound, color, 1960. Audio-Visual Education Service, University of Minnesota, Minneapolis 14.

This new film on game management principles deals with the problems of animal population and population changes. It attempts to explain the need for wildlife preservation and control and the work of the game biologist. The "big four" referred to in the title are four factors involved in wildlife population behavior—environmental conditions, wildlife population capacity of individual habitats, reproduction, and the surplus of game animals available for harvest.

Film: How Our Town Saved the River. 16mm., sound, color, 1960. Portland Cement Association, 33 West Grand Avenue, Chicago 10, Illinois.

This new water pollution film will be of particular interest to communities which are considering bond issues for the construction of waste treatment plants. It may be booked on a free loan basis through the district offices of the Association.

Film: Water . . . Its Many Voices. 16 mm., 22 min., color, sound. Allis-Chalmers Manufacturing Co., Milwaukee 1, Wisconsin.

This film explains the small watershed program with emphasis on depicting the opportunities available to earthmoving contractors in completing many projects associated with watershed development.

Film: Watershed. 16 mm., 26½ min., color, sound. Pack Foundation Watershed Conservation Education Project, University of New Mexico, Albuquerque.

This is a down-to-earth story of what may happen when man upsets the delicate balance between soil, water, plants, and animals on the land. This picture story will appeal to people of all ages. Action shots and meaningful animation are used to tell about the watershed and its vital role in man's welfare.

Chart: Conservation Chart. 28" x 44", 4 colors. Sport Fishing Institute, Bond Building, Washington 5, D. C. $0.60.

This chart shows two valleys. In one, the resources have been carefully conserved, while in the other they have been destroyed. It would be a useful addition to a teaching aids file designed for children in the third through eighth grade.

Welcome to the Hoosier State!

YOU are part of the plans being made for the 1961 Annual Meeting at Purdue University, Lafayette, Indiana, July 30-August 2. You will want to join the many other families who will combine this annual meeting with a vacation, visiting some of the beautiful state and national parks in Indiana and surrounding States. There are also many active Public Law 566 Watershed Projects and Soil and Water Conservation Research Stations in the Hoosier area that will be of specific interest to *Society* members.

A PREREGISTRATION AND PREPAYMENT system has been instituted this year. This will permit arrangements to be made for necessary facilities and services on the basis of actual numbers, but more important, it will reduce your registration inconvenience on arrival. Purdue University will mail to you in advance your housing assignment and meal book(s). This will permit you to go directly to your housing unit when you arrive. You may go to your first meal, if you have prepaid for your entire family, before registering at headquarters in the East Foyer of the Memorial Center. Then you may pick up your badge, program material, etc., or you may do this before eating.

Since this will be during the summer, and University housing will be operating on a limited staff basis, we can assure desirable and adequate accommodations and services only for those who *preregister and prepay prior to July 1, 1961.* Refunds to preregistrants will be made in full for all cancellations received in writing or by telegram on or before midnight, Sunday, July 30, 1961.

Those who do not preregister will suffer the inconvenience of waiting in long lines and may have to take less desirable facilities.

A minimum preregistration payment is required *only* for the head of each family or each single registrant. This will include:

Purdue University Conference Fee	$ 3.00
SCSA Registration Fee	3.50
	$ 6.50
Board (Flat rate for Sunday dinner through Wednesday lunch. This is required for all those living in University housing)	11.30
Total	$17.80

For your convenience you are encouraged to also prepay, but this is optional, the board charges for your wife and/or children at the following rates: Wife, $11.30; Children over 11 years of age, $11.30 each; Children from 2 to 11 years, $5.65 each; Children under 2 years of age, no charge.

Do not prepay your University Housing charges. Room rental will be collected upon arrival.

WHEN filling out your preregistration form be sure to consider one of the three different tours that are being scheduled for Wednesday afternoon, August 2. There are also two ladies' tours that will be conducted during the course of the ladies' program. The principal features are described here to help you make a choice. Men's tour charges will be approximately $2.00; ladies' tours are free.

South Tour. Soil and Water Conservation Research at Purdue-Throckmorton Farm. A rainfall simulator used for erosion control research will be in operation.

East Tour. Well planned conservation practices on family type farms.

North Tour. A hybrid seed corn producer with the world's record for large scale field production. Modern techniques used on a very productive soil.

Women's Historical Tour. A visit to "Battleground," the site of a significant battle in the history of Indiana. A visit to a reconstructed block house of Fort Ouiatanon along the Wabash River.

Women's National Homes Tour. Visit the factory of a noted manufacturer of prefabricated homes.

MANY of the recreational facilities of Purdue University will be available to families either at no cost or at the same nominal fee charged to University staff members.

Swimming. A large Olympic size outdoor swimming pool will be open with an admission charge of 35 cents per person.

Golfing. Two 18-hole golf courses will be available with a charge of $1.00 per person.

Athletic Equipment for Outdoor Games. Equipment will be furnished free on a check out basis from the recreational gymnasium.

ALL MEETINGS will be enjoyed in the air conditioned comfort of the modern, spacious Memorial Center or the beautiful 6,100 seat Hall of Music.

Adequate lounge facilities are available in the Memorial Center and Union. These will add to your pleasure as they are ideal for visiting and for small group meetings.

Chairmen of the various committees for the Society's annual meeting at Purdue University meet for a work session. Standing (left to right): Ralph Ewalt, Exhibits; Bill Briggs, Hospitality and Entertainment; R. O. Cole, Facilities and Transportation; Harold Scholl, Soil and Water Conservation Tours; Ward Studor, Steering Committee; and Clint Morgan, Finance Committee. Seated (left to right): Charles McKee, Chairman, Hoosier Chapter; Frances Guernsey, Women's and Children's Activities; Harry Galloway, Local Arrangements Chairman; A. R. Bertrand, Hoosier Chapter representative on 1961 SCSA Program Committe.

Ping-pong, Shuffleboard and Record Room. Families will be encouraged to use free ping-pong and suffleboard facilities. A free record room will also be open.

Bowling and Billiards. Fourteen bowling alleys and a billiard room will be open for use by convention guests at a nominal charge.

Living Accommodations on Campus

Notice: Pets are not allowed in any University housing.

Union Club. The Union Club is an excellent 257 room guest facility of the University, operated as a part of the Purdue Memorial Union. Rooms are of hotel-type—all with private bath or shower. Only a few rooms are air-conditioned. Rates in general vary from: Single, $5.00-$6.00; double room with double bed or twin beds, $7.00-$9.00.

All single women requesting University housing will be accommodated in the Union Club. *In general,* preference will be given to early registrants and those requesting or willing to accept double accommodations.

Men's and Women's Residence Halls. As fine student accommodations are available at Purdue University as can be found on any college campus. These facilities are frequently used for adult conference groups to include married couples and families, and have proven most satisfactory for this modified use. As far as possible, assignments for families, married couples and single men will be in separate areas of the same hall or in separate halls.

Only limited numbers of rooms can be rented for single occupancy, and these will be available only to those who preregister early. If you desire to occupy a double room with a friend please submit preregistration forms as nearly at the same time as possible, and preferably, in the same envelope.

Rates. Room rental charges per person, per night are as follows: Single occupancy $3.50; Double occupancy $2.50.

Services in Halls. Limited daily maid service is provided (does not include bed making). All bedding and towels are furnished.

No cribs or other special services are available for infant care. Such items as rubber sheeting should be provided by the parents of small children. An infant may occupy the parents' room without charge if a crib or basket is provided by parents. All other children will be assigned to beds. Children will be assigned rooms adjacent to the parents and will be charged only at the double rate of $2.50, although only one child may be assigned to the room.

Hall Facilities. All rooms are spacious and well equipped. The beds are fitted with coil springs and interspring mattresses. No rooms are air conditioned. Nearly all are equipped for double occupancy.

A central lounge is available in each Hall for use of visitors and there are smaller lounges which may be used for visiting with friends.

All requests for University housing space must be made on the preregistration form; they will be handled by the Local Registration and Housing Committee. Individual requests direct to the housing facility cannot be honored. No advance payments are desired. Payment should be made on arrival.

Other Than Campus Housing

As a convenience to all registrants, a list of visitors will be maintained. If you do not desire campus housing, please fill in your convention address on the preregistration form.

Camping. "The Hills," a Purdue University owned park on a bluff overlooking the Wabash River and eleven miles from the convention sight has a limited number of campsites available at a cost of $1.00 per night. If you plan to camp or bring a house trailer, indicate this on the preregistration form and specific information will be sent to you concerning our facilities. If you plan on camping in Indiana enroute to the convention, we will send information on camping in Indiana state parks.

One of the H Dormitories on the campus of Purdue University, which will house SCSA members and families attending the 1961 annual meeting.

Motels and Hotels. There are motels and hotels for those who do not desire Purdue University dormitory or Union facilities. You will have to make your own reservations for these outside accommodations. Addresses given are all in Lafayette, Indiana.

Aretz Motel, *State Road 25.* Double—$7.50, Single—$5.50.

Cedar Crest Motel, *By Pass 52.* Double—$8.50, Single—$6.00 and $7.50.

Colonial Motel, *Road 52 South.* Double—$8.00 (with TV), Single—$6.00 (without TV).

Combs Motor Court, *1510 Schuyler Avenue.* Double—$6.50, Single—$5.50, Twin—$8.50.

Devon Plaza Motel, *2371 N. 26th Street.* Double—$8.50, Single—$6.75.

Esquire Motel, *By Pass 52 North.* Double—$8.50, Single—$7.00, Twin—$9.50 and $10.50.

Green Acres Motel, *Road 52 North.* Double—$7.50-$8.50, Single—$6.00.

Howard Johnson's Motor Lodge. Double—$9.50, Single—$7.50.

Jones Windmere Motel, *Road 52 South.* Double—$6.00-$8.50, Single—$5.00-$6.50.

Lahr Hotel, *505 Main Street.* Double—$7.50-$9.00, Single—$4.50-$6.50.

Marracks Motel, *Road 52 North.* Double—$7.00, Single—$7.00.

Morris Bryant Hotel, *Road 52 North.* Double—$8.50, Single—$6.50.

Van Orman-Fowler Hotel, *407 Ferry Street.* Double—$9.00-$10.50, Single—$5.50-$7.50.

ALL MEALS, except for the Tuesday evening barbecue, will be served in the excellent, air-conditioned cafeteria of the Purdue Memorial Union. "Open" meal service on a cash basis will be available prior to the evening meal on Sunday, July 30 and after lunch on Wednesday, August 2. All meals from the evening meal on Sunday, July 30 through lunch on Wednesday, August 2 will be available *only* to those possessing a "meal book" or specialized individual meal tickets as indicated below.

All participating registrants as well as wives and children who reside in either the Union Club or residence halls must purchase a meal book. Off-campus registrants, wives and children may also purchase a meal book. They may also buy higher rate individual meal tickets (number may

"In Hoosier Land"

A. J. PROCTOR

THE ANNUAL MEETING—1961 of the *Soil Conservation Society of America* will be held in one of the world's richest agricultural areas, the Corn belt. Though famed for the production of corn and hogs, steel and oil, Indiana also boasts outstanding attractions that no SCSA'r will want to miss on his way to Purdue University in late July.

Terre Haute, in southern Indiana, was the home of Paul Dresser who wrote the oft' sung lines "On the Banks of the Wabash." This area is now one of the coal mining centers of the Nation. Individuals with a bent for exploration will find Wyandotte Cave, which has the world's largest underground mountain, an interesting stop. Not too distant is French Lick Springs, where a doctor bottled the water bubbling from the ground, named it Pluto Water, and proceeded to make a fortune. Other interesting stops in southern Indiana would include New Harmony, site of two disastrous experiments in communal living long before anyone ever heard of Karl Marx.

A. J. Proctor is director of the transportation department for the Indiana Chamber of Commerce, Indianapolis.

(Continued from page 88)

be limited) during registration. They may also eat off campus. Refunds on meal books cannot be granted for late arrival, early departure or occasional meals missed. Meal book rates are as shown on the advance registration form.

Shorts or other abbreviated attire are customarily not worn in the dining room.

FOR THOSE who find it more convenient to travel by other than private auto, Lafayette has convenient air, rail and bus facilities.

Airlines. Lake Central Airlines has 10 flights daily from terminal points of Detroit, Chicago, Cincinnati, and Indianapolis.

Train. New York Central has two trains daily from Chicago and Cincinnati. Wabash has two trains daily from St. Louis and Detroit. Monon has one train daily from Chicago and one from Louisville.

Bus Lines. There are convenient schedules by three intercity bus companies, Greyhound, Indiana Motor Bus and Southeastern Trailways.

Private Planes. There are landing facilities and parking available at Purdue Airport, one mile from the convention.

Headquarters for the 1961 SCSA annual meeting will be in the Purdue University Memorial Union and Memorial Center Building. All meetings rooms are air conditioned.

THERE are 18 excellent state parks in Indiana. For the family that likes to camp, Indiana has equipped its state forests with camping facilities. Many lakes in the State draw the avid fisherman and bluegills, black bass, pike, trout, walleyes, and perch often find themselves on the end of a line.

INDIANAPOLIS, the state capital, has preserved the homes of James Whitcomb Riley, the "Hoosier Poet," and Benjamin Harrison, 23rd President. The city is the home of the American Legion's headquarters and every soldier in the U. S. Army gets his checks from the Finance Department at Fort Benjamin Harrison. Garfield Park has outstanding floral displays in the summer and the Scottish Rite Cathedral is world-famed for its architecture.

Visitors in northern Indiana can see Fountain City (shove a length of pipe into the ground here and it is said one can get free running water from an underground lake), headquarters for runaway slaves between 1827 and 1847. Muncie, home of Ball Brothers Glass Jar Company, was the subject of the book *Middletown,* a study of a "typical" small U. S. city. Wabash makes a strong claim to have been the first city in the U. S. to be lighted by electricity.

ELKHART COUNTY has a large proportion of Mennonites, most of them of Swiss origin, and at Goshen is the only four-year Mennonite college in the U. S. The Amish continue to wear plain black clothing without buttons, and disdain automobiles, television, telephones, amusements and life insurance. Near Lafayette, home of Purdue University and site of the 1961 National *SCSA* Convention, is the Tippecanoe Battlefield which marked the end of Indian influence in the Territory.

FROM Gary to the Illinois state line are the Cities of the Calumet, one of the most remarkable urban-industrial complexes in the nation. Included are Gary, Hammond, East Chicago and Whiting. In 1905, this 16 mile stretch of real estate had a population of 19,000. The towns and villages sat on swampland and sand dunes. Today 3,000,000 people live and work in the Calumet region, a great progression of industrial plants, docks and railroad tracks. The string of nearly 200 factories includes refineries, steel mills, soap factories, electrical generating units and many others. Day or night, the Calumet area is awesome. Towering stacks belch gray smoke into the skies and steel carrying cables thread the air, while the din of drop forges and dumping slag is heard over everything else. At night, open hearth furnaces light the sky for miles. Observing the Calumet region in action, the visitor gets an indelible impression of the industrial might of America.

BUT the greatest resource of the State is its people. Hard work and cooperation have earned Indianians the name "Hoosier." Legend says a contractor named Sam Hoosier preferred the work gangs from Indiana to all others when he was building the Ohio Falls Canal at Louisville in 1825. Soon those on his payroll were all from Indiana and they became known as "the Hoosier men." Indianians are proud to retain that name today. But by whatever name you call us . . . come and visit. Combine a delightful vacation with attendance at the 16th annual meeting of the *Soil Conservation Society of America.* Send in your advance registration form today!

See pages 92 and 93 for the program of the 16th annual meeting of the Society.

The Society in Action!

The Council of the *Soil Conservation Society* held its spring meeting in Des Moines on January 28, 29, 30, 1961, with all members present. Action taken by the Council:

1 Selected a design for the Society's new home from five sketches presented by the architect. The selection is shown on the center insert of this issue of the JOURNAL. The Council also accepted the report of the Building Fund Committee indicating that $58,000 in cash and pledges have been made. A time table was adopted calling for completion of the architect's plans and specifications by June 1, 1961 and letting bids in July of 1961. This is contingent upon having 60 to 70 percent of the necessary funds on hand by that time.

Action was taken to open as many accounts as necessary to protect the building funds through deposit in Federally insured institutions. The money has been deposited with various savings and loan associations currently paying 4 percent in dividends.

2 Determined that memorial funds will be accepted in the name of the deceased individual and spread upon the records of the Society with funds to be used for the new building unless otherwise indicated by the donor.

3 Accepted the membership report indicating that the Society had a membership of 10,643 on December 31, 1960.

4 Accepted the report of the Editor and established two committees to work with him, one on the matter of a photo contest for Society members and another on compiling and maintaining a list of audio visual aids for use by members and others.

5 Authorized the printing of the Society's new booklet "Help Keep Our Land Beautiful" and reprinting the publications "The Story of Land," "The Wonder of Water," and "Down the River."

6 Authorized the Executive Secretary to seek a cosponsor for the Spanish translation of the Society's "Glossary of Soil and Water Conservation."

7 Authorized the Chapter Activities Committee to hold special chapter workshop planning sessions at the annual meeting.

8 Outlined final arrangements and program for the Society's 16th annual meeting to be held at Purdue University, Lafayette, Indiana, July 30, 31, August 1, 2, 1961.

9 Approved organization of six new technical study committees as follows:

(a) Research
(b) Urban-Suburban Conservation Problems
(c) Mined Area Restoration
(d) Conservation Education
(e) Land Planning and Zoning
(f) Outdoor Recreation

10 Announced that it will be the intent of the Council to consider a change in dues for the year 1962 and thereafter for members of the Society who have retired and who have been members for four years. The proposed rate would be one-half of the regular dues if qualified individual requested the special rate. Chapters would act independently with regard to Chapter dues. This notice is to be considered as meeting the requirement of the bylaws in regard to notifying members and chapters of the Council's intent. Opinions of members are solicited.

11 Adopted a budget of $85,705.00 for the fiscal year 1961-62. The sale and income of booklets was removed from the regular operational budget and a separate budget established. A study of operating costs indicated that a membership of 12,500 is necessary before the JOURNAL OF SOIL AND WATER CONSERVATION becomes a monthly publication. It was predicted that membership would reach this figure in 1964.

12 Restated the intent to hold the 1963 annual meeting in Utah with final arrangements to be made with Utah Chapter.

Selected the Benjamin Franklin Hotel in Philadelphia as headquarters for the annual meeting, August 22, 23, 24, 25, 1965.

BUILDING FUND

YOUR PERSONAL contribution to the building fund may be made either through a chapter of the *Society* or directly to the *Society* headquarters office. Use the form on the left!

In addition to lump sum gifts and pledges to the building fund, the Council has directed that sustaining memberships in the Society shall be directed toward building construction. Individual sustaining membership in the *Society* is $27.50 a year, plus local chapter dues of $1.00-$2.00 a year. The amount above the regular membership fee of $7.50 is credited to the building fund unless specified otherwise by the member. Indicate your desire for an individual sustaining membership when you send the form on the left.

In addition to the Hugh Hammond Bennett building fund, which is to be used by the *Soil Conservation Society of America* to erect a permanent Society home dedicated to the memory of Dr. Bennett, memorial funds in the names of other individuals have been established.

These various funds will also be used for construction of the building and have been designated by the donors in the name of outstanding conservationists whom they wish to honor. The Council (governing body of the *Society)* has designated that these contributions will be made a part of the permanent *Society* records.

Memorial funds have now been established in the names of the following men:

WILLIAM FRANK PURNELL
H. R. BEESON
J. S. RUSSELL
NEWMAN I. LYLE
FRANK V. D. CORTELYOU

BUILDING FUND PLEDGE
Soil Conservation Society of America

To: Treasurer_____Chapter, SCSA
or
Treasurer SCSA, 838 Fifth Avenue, Des Moines 14, Iowa

Enclosed is:
$_____to be credited to the SCSA Building Fund
and
I (We) hereby pledge $_____ to be paid each year on
_____ for the next _____years.
(month) (day)

Or:
I (We) hereby pledge:
$_____ to be paid on _____
and *(month) (day) (year)*
$_____ to be paid each year _____
(month) (day) (year)
for the next _____years.

Signed:_____
_____
(address)
_____

Progress Toward a Home for SCSA

See the letter to all members from Society president, Walter Gumbel, on page 50. Refer to the center insert depicting and describing the permanent Society home.

Chapters and individuals are working diligently to meet the goal of 60-70 percent of building construction costs deposited by July 1, 1961.

Several individuals and groups have made sizable contributions in memory of conservationists whose names they wish to honor.

All Society members and friends are urged to make immediate use of the pledge form on the facing page.

Building Fund Report – March 1, 1961

Chapter	Chapter Pledge	Individual Unpaid Pledges	Paid to Date	Other Evidence of Support
No Affiliation		$ 80	$ 563.00	
Washington, D. C.	$5,000	2,796	1,656.42	(2)
South Dakota		35	1,210.25	
Lincoln *(Nebr.)*			131.00	(1)
Salina *(Kans.)*			70.50	
Bozeman *(Mont.)*		20	54.00	
Wisconsin	2,400	32	476.00	(1) (2)
Wm. Penn *(Pa.-Del.)*	400	40	337.50	(2)
South Carolina		84	345.55	(1)
North Texas		8	124.50	(1)
Rio Grande *(N. Mex.)*	75		130.00	
Inland Empire *(Wash.-Idaho)*			148.00	
Empire State *(N. Y.)*	2,000	24	502.00	(2)
California		37	1,357.75	(2)
West Virginia	3,000	710	2,047.00	(2)
Pocomoke *(Md.)*			80.00	(1) (2)
Keystone *(Pa.)*	1,000	16	115.00	
So. New England *(Conn.-Mass.-R. I.)*		24	58.00	(1)
New Jersey	1,250	28	1,053.00	(2)
N. E. Oklahoma		8	202.32	
El Paso County *(Colo.)*	250		10.00	
Michigan	2,500	317	421.75	(1) (2)
Northern Kentucky			25.00	
Hoosier *(Ind.)*			396.25	(1) (2)
Blue Grass *(Ky.)*		8	53.00	(2)
Virginia	2,500	68	931.50	(2)
Kentucky Lake	250		71.50	(2)
Florida		268	327.00	(1)
Mississippi		68	38.00	
Utah		40	50.00	
Arizona		22	89.00	
Georgia	5,000	28	307.50	(2)
North Carolina	5,000		521.00	(1)
Green River *(Ky.)*			50.00	
Iowa	5,000		1,983.25	(2)
Manhattan *(Kans.)*		90	237.00	(2)
Ontario *(Canada)*	1,600		1,298.00	
Central Oklahoma		8	35.00	
Minnesota	1,600	113	354.75	(2)
Lake Cumberland *(Ky.)*			5.00	
S. C. Oklahoma	100		58.00	
S. C. Nebraska		81	180.00	(2)
N. New England *(Maine-N. H.-Vt.)*	1,480		55.00	(1) (2)
Ozark Mt. *(Ark.)*			25.00	
Egyptian *(Ill.)*	250		71.00	(2)
Border *(N. Dak.)*			15.00	
Pony Express *(Kans.)*			144.39	(1)
East Texas	250	73	135.50	(2)
Northern Illinois	2,600	484	492.20	(2)
Custer *(N. Dak.)*		4	62.50	
Upper Kentucky River *(Ky.)*			40.00	(1)
North Alabama		20	25.00	
South Alabama			186.50	(1)
Show-Me *(Mo.)*			221.00	
West Tennessee	570	14	161.00	(2)
Old Line *(Md.)*	1,500		519.00	(2)
All Ohio	1,000		358.00	(1) (2)
East Tennessee	900	8	56.00	(1) (2)
High Plains *(Kans.)*		8	49.65	
E. C. Oklahoma			102.25	
Big Hunt *(Okla.)*			22.25	
Stillwater *(Okla.)*			55.50	(2)
R. N. Irving *(Idaho)*			140.50	(2)
Southwest Oklahoma		8	102.00	
Bob White *(Kans.)*			20.00	
Santa Fe Trail *(Kans.)*			10.00	
Bluestem Hills *(Kans.)*		24	31.00	
Wyoming		24	64.00	
Southeast Oklahoma			13.50	
Olympic View *(Wash.)*			15.00	
Oregon		160	100.00	(1)
Andrew Jackson *(Tenn.)*	1,000	79	306.50	(2)
Ft. Hays *(Kans.)*			22.00	
Northwest Oklahoma			2.00	
Louisiana			100.00	
Puerto Rico			50.00	
Ark. River Bend *(Kans.)*	320		19.00	(1) (2)
Korea			20.00	(1)
Central Arkansas	800	8	71.50	
Southwest Nebraska			16.00	
Blue-Nemaha *(Nebr.)*			10.00	
Northeast Nebraska			39.00	
Heart of Texas		10	730.41	
Western Puerto Rico			10.50	
Total	$49,595	$5,977	$22,793.94	41
Interest earned			$ 204.06	
Total on deposit			$22,998.00	

(1) General Chapter Support

(2) Chapter Building Fund Committee Organized

"LAND USE IN A CHANGING AGRICULTURE"

PROGRAM

SOIL CONSERVATION SOCIETY OF AMERICA

Sixteenth Annual Meeting

Purdue University

Lafayette, Indiana—July 30, 31, August 1, 2, 1961

SUNDAY, JULY 30

2:00-
10:00 p.m.—Check into rooms and complete registration at your convenience in Memorial Center. (Dormitories will open at 9:00 a.m. and close at 11:00 p.m.)

5:00-
7:00 p.m.—Evening Meal—Memorial Union.
7:30 p.m.—Social Hour—Hoosier Chapter SCSA.

MONDAY, JULY 31

7:00-
9:00 a.m.—Breakfast—Memorial Union.

8:00 a.m.—Check into rooms and complete registration in Memorial Center.

9:00 a.m.—MORNING SESSION—Loeb Theatre, Memorial Center.
Presiding: FRANK H. MENDELL, Chairman, Annual Meeting Program Committee, SCSA, Des Moines, Iowa.
Welcome to Indiana—R. F. WHITSITT, Chairman, Hoosier Chapter SCSA, Indianapolis, Indiana.
Welcome to Purdue—E. L. BUTZ, Dean of Agriculture, Purdue University, Lafayette, Indiana.
Land Use in a Changing Agriculture—WALTER C. GUMBEL, President, Soil Conservation Society of America, Fairmont, West Virginia.
The Soil Conservation Society of America in 1961—H. WAYNE PRITCHARD, Executive Secretary, SCSA, Des Moines, Iowa.
Report of the Treasurer—HOWARD F. BARROWS, Treasurer, SCSA, St. Augustine, Florida.
The Society's Development Fund Board—FIRMAN E. BEAR, Chairman, New Brunswick, New Jersey.
Committee Reports—Chairmen of Committees.
Society Recognitions

11:30 a.m.-
1:00 p.m.—Lunch—Memorial Union.

1:30 p.m.—AFTERNOON SESSION—The afternoon program will consist of six workshops for chapter representatives. Room location will be announced in the final draft of the program. (Advance information will be sent directly to chapters.)
For those not attending the chapter program planning workshops, the Society's technical committees will hold open meetings at which the chairman will discuss the work of the committee and call for audience participation.

3:15 p.m.—Reports to the entire assembly from the various workshops and committee meetings.

5:00 p.m.-
7:00 p.m.—Dinner—Memorial Union.

7:30 p.m.—EVENING SESSION
Presentation of Fellows and Honorary Members.
Speaker—To be announced.

TUESDAY, AUGUST 1

7:00-
8:30 a.m.—Breakfast—Memorial Union.

9:00 a.m.—MORNING SESSION—Loeb Theatre, Memorial Center
Presiding: AUSTIN L. PATRICK, Council Member SCSA, Arlington, Virginia.

Population Trends and Food Production in a Changing Agriculture—JOHN F. TIMMONS, Professor, Department of Economics and Sociology, Iowa State University, Ames, Iowa.

9:45 a.m.—Symposia

1. USE OF WATER RESOURCES—Room 214, Memorial Center
Moderator: H. G. BOBST, Field Representative, Soil Conservation Service, Lincoln, Nebraska.
A. **Reducing Water Requirements of Plants**—W. J. ROBERTS, Engineer, Illinois State Water Survey, Urbana, Illinois.
B. **Use of Plastic Films and Plant Orientation in Reducing Evaporation**—M. B. RUSSELL, Head, Department of Agronomy, University of Illinois, Urbana, Illinois.
C. **Water Management in Farm Planning**—D. E. HUTCHINSON, State Soil Conservationist, Soil Conservation Service, Lincoln, Nebraska.

2. LOOKING AHEAD IN LIVESTOCK PRODUCTION—Room 218, Memorial Center.
Moderator: B. K. GERAGHTY, Council Member, SCSA, Manhattan, Kansas.
A. **Trends in Feed Sources for Livestock**—(To be filled.)
B. **Soil Mineral Deficiencies and Livestock**—W. H. ALLAWAY, Director, U. S. Plant, Soil and Animal Nutrition Laboratory, Agricultural Research Service, Ithaca, New York.
C. **Effect of Sprays on Crop and Livestock Production**—CLARENCE COTTAM, Director, Welder Wildlife Foundation, Sinton, Texas.

3. USING SOILS INFORMATION—Room 202, Memorial Center
Moderator: N. R. RICHARDS, Council Member, SCSA, Guelph, Ontario, Canada.
A. **Use of Soils Information in Planning and Development in Urban Fringe Areas**—L. J. BARTELLI, State Soil Scientist, Soil Conservation Service, Champaign, Illinois.
B. **Storms and Conservation Practices**—W. H. WISCHMEIER, Project Administrator, Soil and Water Conservation Research Division, Agricultural Research Service, Purdue University, Lafayette, Indiana.
C. **Minimum Tillage, Objectives and Benefits**—W. E. LARSON, Soil Scientist, Eastern Soil and Water Conservation Branch, Agricultural Research Service, Iowa State University, Ames, Iowa.

4. WATER NEEDS AND BASIN STUDIES—Room 206, Memorial Center.
Moderator: HERBERT A. HOPPER, Council Member, SCSA, Lafayette, California.
A. **Water Needs for Recreation**—(To be filled.)
B. **Water Needs for Industry and Municipalities**—EVERETT T. WINTER, Executive Vice President, Mississippi Valley Association, St. Louis, Missouri.
C. **River Basin Studies, Planning, and Development**—ALVIN C. WATSON, Northwestern River Basin Representative, U.S.D.A., Soil Conservation Service, Upper Darby, Pennsylvania (and another speaker to be named)

11:30 p.m.
1:00 p.m.—Lunch—Memorial Union.

1:30 p.m.—AFTERNOON SESSION—Loeb Theatre, Memorial Center.
Presiding: GEORGE M. BROWNING, Second Vice President, SCSA, Ames, Iowa.
Value of Resources Conservation to People—(To be filled)
Challenge to State Governments in Soil and Water Conservation—(To be filled)
Challenge to Education in Soil and Water Conservation—(To be filled)

2:15 p.m.—(Following the above presentations the assembly will divide into three symposia on the same subjects.)

5:30 p.m.—HOOSIER STYLE BARBECUE—Compliments of Hoosier Chapter, SCSA—Followed by entertainment.

WEDNESDAY, AUGUST 2

7:00—
8:30 a.m.—Breakfast—Memorial Union.
8:30 a.m.—Morning Session—Loeb Theatre, Memorial Center.
Presiding: ROY D. HOCKENSMITH, Vice president, SCSA, Washington, D. C.
Planning and Zoning for Proper Land Use (Tentative title)—D. G. ALDRICH, Dean of Agriculture, University of California, Berkeley, California.
Conservation Needs in a Changing Agriculture—D. A. WILLIAMS, Administrator, Soil Conservation Service, Washington, D. C.
Forestry Needs Ahead—(To be filled)
Summary of AAAS Symposium on Land Use—FIRMAN E. BEAR, Editor, Soil Science, New Brunswick, New Jersey.

11:30 a.m.—Lunch

AFTERNOON SESSION—Tours will begin immediately following the morning session. Box lunches will be provided those going on a tour and others will eat at the Memorial Union. Tours will be made by bus and advance registration for them should be made on the registration form.

For those desiring to remain Wednesday night at Purdue University, evening meal, overnight lodging and breakfast can be purchased on campus.

LADIES' PROGRAM

A complete program featuring the theme "Conservation of Human Resources" is being organized for the women attending the SCSA annual meeting. Of course, the ladies are always welcome at the regular meeting sessions, or they may use the many recreational facilities available.

Plans include tours of the Purdue University campus, coffee hours, and card games. A children's program featuring stories, movies and games will also be in operation.

Detach and Mail To: SCSA, Box 647, West Lafayette, Indiana

ADVANCE REGISTRATION AND PREPAYMENT FORM

Remember! 1. Return this form and payment prior to July 1, 1961.
2. A separate registration form must be submitted for each participating registrant (spouse and/or children should be listed on this form).
3. Make check payable to *"Purdue Ag Conferences."*

Name _____
(Mr. Mrs. Miss) (Circle one) (Last) (First) (Initial)

Address _____
Street

_____
(City) (State)

SCSA Chapter _____

Accompanied By: (Include first name)	Relationship	Age of Children

SPECIAL EVENTS *(Indicate number of persons listed on this form who will attend):*

EAST TOUR_____ NORTH TOUR_____ SOUTH TOUR_____

LADIES' TOURS: HISTORICAL _____ HOMES_____

ARRIVAL: Date _____ Hour _____ Mode _____ DEPARTURE: Date _____ Hour _____ Mode_____

If travel by Lake Central Airlines, give flight No.:_____ ARR.: _____ DEP.: _____

I will land by private plane at the Purdue University Airport: _____

HOUSING:

I have arranged for my own housing at: _____

I request University Housing (give order of preference 1, 2, 3, 4, 5).

UNION CLUB: _____ Single _____ Double _____ Double-Twin

RESIDENCE HALLS: _____ Double _____ Single *(very few available)*

Roommate Request (must accompany this form): _____
Name Town

Special Requirements (i.e. Health, etc):_____

Please send information on: _____ Camping _____ Camping enroute only _____ Trailer Space

I have enclosed a check for:

MINIMUM ADVANCE PAYMENT OF
CONFERENCE AND REGISTRATION FEE .....$ 6.50
PARTICIPATING REGISTRANT'S MEAL BOOK @ $11.30 .....
and OPTIONAL advance board payment of: Wife @ $11.30 .....
Children over 11 @ $11.30 each .....
Children 2-11 @ $5.65 each .....

Remember! Make checks payable to *"Purdue Ag Conferences"* TOTAL ....$_____

CHAPTER NEWS

North Carolina Chapter—A fresh, promising idea to raise funds for the establishment of the Hugh Hammond Bennett Professorship in Soils at North Carolina State College is now being promoted by the North Carolina Chapter of the *Soil Conservation Society of America*. Known as the Hugh Hammond Bennett Professorship Pond Project the plan is to utilize a conservation practice stemming from the conservation leadership of Dr. Bennett to obtain funds in support of the professorship.

The procedure provides that in each county in North Carolina a number of farm ponds will be designated, with the cooperation and support of the owner, as H. H. Bennett Professorship Ponds. After suitable publicity the ponds will be opened to the public for fishing during the period May 8 through June 10. Tickets costing $1 each and allowing an individual to fish in one of the ponds will be sold. Also, a fishing rodeo may be held in each county during the last week of the project.

The December issue of the North Carolina Chapter newsletter indicates that $1,580 has already been given toward the professorship fund, and $1,250 has been pledged.

Iowa Chapter executive committee has held three meetings since election last October. President Walter Weiss and Joe O'Hara, president of the Iowa Association of Soil Conservation Districts, are working diligently toward securing SCSA building fund contributions from each District governing body in Iowa.

Progress on development of the 15 year index of the JOURNAL OF SOIL AND WATER CONSERVATION is reported by Dr. Wallace Akin and his committee.

Southern New England Chapter held their annual chapter meeting on March 2 at Nichols College, Dudley, Massachusetts. Under the leadership of Mrs. Hester Underhill, assisted by Miles Hubler, John Helein and Gayland Golley a program built around "Conservation Problems Outside the Agricultural Field" was presented.

Kansas Chapters have planned a second annual statewide meeting for June 9 and 10. "Agriculture of Tomorrow" will be the theme of the program planned for presentation in the Baker Hotel, Hutchinson, Kansas.

Mississippi Chapter held its fifth annual meeting on November 29 at the King Edward Hotel in Jackson. "Conservation Leadership in the New South," theme of the meeting, was ably presented by Boswell Stevens and Sidney Livingston.

Tennessee Chapters were responsible for the organization of a statewide Land Judging Contest. The contest is open to all bona fide F.F.A. and 4-H Club members in the state. It will be conducted on three levels, county, district, and state, with awards totaling $2,250 available.

Secured as sponsor for the contest is the Tennessee Farmers Mutual Insurance Company. In cooperation with the chapter other groups supporting the endeavor include the Agricultural Extension Service, Soil Conservation Service, State Vocational Agriculture Department, Association of Soil Conservation District Supervisors, Agricultural Experiment Station, Farm Bureau, State Department of Agriculture and County Agricultural Extension Committees.

In a colorful brochure the objective of the contest is stated: "Land judging is designed to give the participants an appreciation of one of our most important resources—the soil. . . . and to cause the youth of Tennessee to understand more clearly the need for classifying land according to its capability in order that it may be used efficiently in production without damage to the land."

Salina Chapter (Kansas). On December 9 the annual meeting was held at Concordia. Senator Frank Carlson brought the 71 members in attendance up to date on some of the pressing problems facing the Nation in the conservation and resource use field today. Elected as chapter president for the coming year was Glen McLaren.

DATES TO REMEMBER

National Water Research Symposium. March 28-30. Washington, D. C.

Eighth National Watershed Congress. April 17-19. Ramada Inn, Tucson, Arizona.

American Society of Agricultural Engineers. Convention. June 25-28. Ames, Iowa.

Soil Stewardship Week. May 7-14. Sponsored by the National Association of Soil Conservation Districts.

National Farm Safety Week. July 23-30. Sponsored by the National Farm Safety Council.

Soil Conservation Society of America Annual Meeting. July 30-August 2. Purdue University, West Lafayette, Indiana.

For further information concerning any of these meetings please contact Society headquarters at 838 Fifth Avenue, Des Moines 14, Iowa.

CAREERS IN CONSERVATION

A colorful, 12 page pamphlet describing opportunities for a career in conservation has been prepared by the *Soil Conservation Society of America*. This interesting bulletin is directed toward high school and college students. It is available from the offices of the Society at 838 Fifth Avenue, Des Moines 14, Iowa.

The pamphlet was prepared primarily for use and distribution through chapters of the Society. It should prove particularly useful to those counselling young people and has a definite place in the "Career Days" now sponsored by many schools.

A chapter might well consider distribution and use of this material as a major educational project. Single copies are free; write for bulk prices.

PROMOTING CONSERVATION

An original idea for putting the "conservation idea" before the public, developed and put into practice by the Santa Fe Chapter (Kansas) of the *Soil Conservation Society of America* has been receiving nation-wide attention.

A chapter member, Hubert E. Pauley, work unit conservationist in the Ford County Soil Conservation District suggested investigation of the possibility of using one side panel of a half-gallon milk carton as a space for a conservation picture and slogan. A committee, headed by Roger C. Arnesdorf, soil conservationist, Ford County Soil Conservation District, and including Orval A. Harold, Great Plains Conservation Program Specialist, as well as Pauley was named to develop the idea. They contacted one dairy serving most of the Santa Fe Chapter area (eight counties) and received permission to use one side of the milk carton at no cost.

Contacts were made with the company supplying milk cartons to the dairy. A $25.00 metallic plate that could be used indefinitely was all that was needed. This the Chapter supplied.

The dairy asked that the picture and slogan be changed each time they ordered cartons, or about every three months (100,000 cartons per order). The Ford County Sportsmen's Club was willing to sponsor the second plate and the Ford County Soil Conservation District paid for the third.

Committee chairman Arensdorf reports that groups in three States have requested detailed information on the project. He has also indicated that if other groups in the Nation would sponsor a similar project plates could be traded and this would further reduce costs.

Save time . . . money . . . crops . . . with

BERMICO®

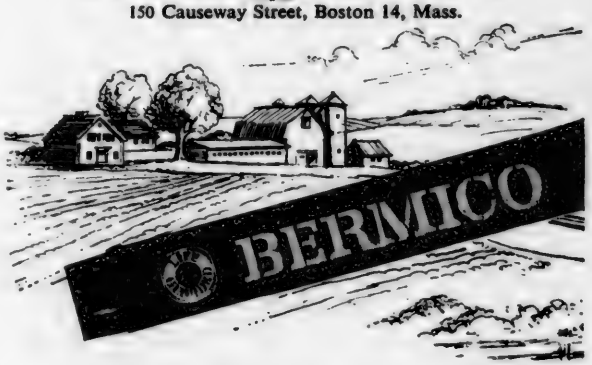
FIBRE PIPE

For trouble-free farmland drainage install Bermico bituminized, perforated fibre pipe. Bermico pipe is lighter and easier to handle . . . lays faster . . . drains off standing water to keep your fields tillable and profitable . . . *outlasts a lifetime and costs you much less than iron pipe.* Ask your dealer for the new Bermico Brochure — or write to our Dept. JS-3.

Another Quality Product of

BROWN COMPANY

150 Causeway Street, Boston 14, Mass.



SNOW

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NEWS OF MEMBERS

Charles H. Stoddard of Minong, Wisconsin, has been named to head the Department of the Interior's Technical Review Staff, according to an announcement by Secretary of the Interior Stewart L. Udall. Prior to his appointment Stoddard was on the staff of Resources for the Future, Inc.

J. B. Washko, professor of agronomy at Pennsylvania State University has been re-elected president of the American Grasslands Council. **W. M. Meyers** of the same institution was named senior vice president, while **E. A. Silver,** New Holland Machine Company, was elected vice president. **Bruce Craine** of the Craine Silo Company was re-elected treasurer. The *Soil Conservation Society of America* maintains active membership in the Council.

Emil R. Hoppe was presented the Inland Empire Chapter plaque for outstanding achievement in the field of professional soil and water conservation, at the December 29 chapter meeting. Hoppe's paper, "Handling Heavy Straw as a Stubble Mulch" was reprinted as a part of the chapter's most recent newsletter.

Richard E. McArdle, Chief of the U. S. Forest Service, recently received the Nation's top civilian career service award. McArdle is only the third USDA employee to receive the award since it was authorized by Congress in 1954. A gold medal was bestowed upon him in ceremonies at the White House.

Harry R. Woodward, director of the South Dakota Department of Game, Fish, and Parks, has been named director of the Colorado Game and Fish Department.

(Continued on page 98)

Charles D. Crocker (third from right) and other American technicians observe the growth of plants and grasses on an eroded area near Seoul, Korea. For the past 3½ years Crocker has been a soils advisor at the U. S. International Cooperation Administration mission in Korea. He helped to set up 140 conservation demonstration villages. Crocker has recently been transferred to Cambodia, but while in Korea founded a chapter of the *Soil Conservation Society of America.*

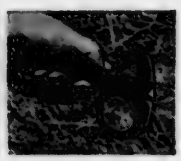
BEMIS MULCHNET

For holding straw or other mulch on critical slopes, on forest-tree nursery beds, etc., while seeds germinate. MULCHNET is a wide-weave, twisted-paper fabric with excellent weathering qualities. Retains 50 to 75% of its tensile strength when wet. Selvage edges and center yarns (used in stapling the material in place) are mildew-treated and reinforced for longer life.

MULCHNET is surprisingly low in cost—only about 4¢ per square yard. And it's fast and easy to apply. See the stapling tool illustration.

BEMIS EROSIONET®

For use without mulch—holds seed in bed and controls erosion on slopes. A twisted-paper fabric, its closely woven, square mesh forms millions of tiny dams which hold seed and sprouting grass firmly in place. EROSIONET also catches and holds moisture, thus aiding germination. Easy to apply; hold in place with staples. Bemis has manufactured EROSIONET for soil conservation and landscaping for more than 25 years.



MULCHNET and EROSIONET are easily and quickly applied

Wire staples and stapling tool designed especially for MULCHNET and EROSIONET make application quick and easy. The tool is quickly loaded and the material is stapled without stooping.

MAIL THIS COUPON TODAY

Bemis Bro. Bag Co., 2400-C S. Second Street, St. Louis 4, Mo.

Please send test-size sample roll of
MULCHNET ☐ EROSIONET ☐

*Name*_____

*Firm*_____

*Address*_____

*City*_____ *Zone*_____ *State*_____

(Continued from Inside Front Cover)

be more productive but will be a more beautiful and pleasant place to live if conservation practices are adopted. It is a vital message told in an interesting manner.

The Society's booklet program is promoted by members through their local chapters. The booklets are used for educational purposes, as handout material at meetings, fairs, and exhibits, and as mailing pieces. They are designed for bulk purchase by business firms, agencies, individuals, organizations, and others. The back page may carry a message of a sponsor.

Prices for the new booklet, delivered to the buyer are as follows:

1-	9	.20
10-	99	.10
100-	499	.065
500-	999	.055
1,000-	9,999	.05
10,000-	49,999	.04
50,000-	and over	.035

Four lines of imprinting may be placed on the back for $4.75/M.

The booklet is now available.

Other Society booklets still available include:

"Down the River"
"The Story of Land"
"The Wonder of Water"
"Dennis The Menace and Dirt"

A total of 3,500,000 booklets of this nature have been printed. They are used with the general public. Supplementing these are Society technical publications:

"Snow Surveys"
"Land Utilization in the United States"
"Our Watershed Resource"
"Glossary of Soil and Water Conservation."

Soil Conservation Society of America
838 Fifth Avenue
Des Moines 14, Iowa

REMEMBER TO GET A NEW MEMBER

IH looks ahead!

You'll soon be seeing this giant 4-wheel-drive tractor! Three-hundred horsepower gives it the speed and pull to set new acre-per-day work records. And it's more nimble than much smaller rigs. It steers with all four wheels . . . even "crabs" to farm steep slopes where only a crawler dare follow. Bold new IH ideas promise a bright future for farmers.

Idea factory is an investment in tomorrow's agriculture

Ten acres under one roof . . . all devoted to developing better farm equipment. That's International Harvester's Farm Equipment Research and Engineering Center at Hinsdale, Illinois.

Here nearly 1,500 men . . . engineers, soils experts, chemists, metallurgists, even atomic scientists . . . look ahead to the needs of tomorrow's farmer. These men know farming and farm needs. The most modern laboratories and facilities in the farm equipment industry are at their disposal. Design, development, and testing of farm equipment go on twenty-four hours each day.

Test machines aren't babied . . . they're abused. In an indoor field, planting, tillage, and other tests continue, rain or shine, the year around. On a test track, tractors pull heavy loads at wide-open throttle, day and night.

Field-going laboratories follow new machines far into the countryside where engineers measure, with amazing precision, the actual stresses and strains of rugged field use.

And at the research center, machines twist and jolt implements being tested to duplicate stress and strain of field use. Thus engineers crowd 10 years of normal farm use into as many weeks . . . wear machines out fast to find and eliminate weak points before new designs go to the farmer.

Building farm tractors and equipment best fitted to the farmer's needs has made IH first in farm equipment. And the greatest research and development program in the industry will put tomorrow's IH farm equipment even farther ahead.

World's biggest farm equipment research center puts 10 acres of tomorrow under one roof. Here, design, development, and testing of farm equipment are carried on by skilled teams, using the most up-to-date equipment and instruments.

INTERNATIONAL HARVESTER

World's largest manufacturer of farm equipment

(Continued from page 95)

Adrian C. Fox represented the *Society* at the American Nature Study Society's 53rd annual meeting in New York City, December 26-30.

Andy Anderson (New York) has completed a major revision of his Farmers' Bulletin No. 2035, titled, "Making Land Produce Useful Wildlife." A most useful publication.

Monroe Hartman has been transferred from the Blacklands Experimental Watershed near Waco, Texas, to the Watershed Research Investigation Project on the Washita River. His headquarters are now at Chickasha, Oklahoma.

George A. Selke, formerly Commissioner of Conservation in Minnesota, was named as asistant Secretary of Agriculture by President John F. Kennedy.

SS-13 REDUCED SEEPAGE 70% in 607,000 gallon pond on Toru Kitahara Citrus Farm, Coachella County, California. Water drop before treatment was 1½ inches per hour; drop after treatment was .45 inches per hour. Palm fronds on bank keep fine, sandy soil from blowing away.

SOIL SEALER-13 SAVES WATER

SOIL SEALER-13 (SS-13) is a liquid compound of resinous polymers and heavy atoms carried in a small proportion of common diesel fuel ● It is miscible with water ● SS-13 is designed primarily for application to sandy, alkaline soils which still leak after maximum compaction under field conditions ● When mixed with the water held in earth reservoirs such as stock tanks, contractors' storage ponds and golf course water hazards, SS-13 reduces seepage by from 60% to 90% ● It is generally applied at a rate of 1 gallon of SS-13 for each 1,000 gallons of water ● It is also effective in sealing irrigation canals ● Cost of application runs between 6 cents and 40 cents a square yard ● SS-13 is approved for the Agricultural Conservation Program Service of Arizona ● SS-13 seals soil by increasing the ionic attraction of soil particles for water which in turn increases the thickness of the hygroscopic envelope of water around each particle ● This reduces the size of the voids through which water can seep ● SS-13 is harmless to humans and animals, but, while in solution, is harmful to fish ●

FOR ADDITIONAL INFORMATION AND EXPERIENCE DATA FILL OUT AND MAIL THE COUPON BELOW.

SS-13

SALES COMPANY

P.O. BOX 4425 • PHOENIX, ARIZONA

Please send me more data concerning Soil Sealer-13 with special reference to its use in.....

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City..... *State* .....

Several individuals with the Soil Conservation Service in Texas received Certificates of Merit and cash awards in recognition of their excellent work. Included were **Ernest P. Krueger,** work unit conservationist, and **Herman Weise,** soil conservationist in the Brehnam Work Unit. Also receiving cash awards and certificates were **Robert E. Daniell,** field specialist in soils at Lubbock; **Victor D. Howell,** soil conservationist at Corsicana; and **Jack C. White,** forester at Woodville.

Sumith Abeywickreme, secretary of the Soil Conservation Society of Ceylon, reports that the second annual meeting of that Society was held on January 19. In attendance at the meeting was **Evan A. Hartman** who has now completed three months of his assignment as International Cooperation Administration, Soil Conservation Advisor to Ceylon.

DEATHS

Samuel J. Smith, State conservation engineer for Connecticut and Rhode Island, passed away November 2, 1960, after a brief illness at West Willington, Connecticut.

John S. James, SCSA charter member 238, died November 13, 1960. He lived in Ontario, California.

Stanley W. Cosby, assistant State conservationist in California, died on January 20, 1961. He had retired from SCS in July, 1960, but was serving an additional year in a consulting capacity. His residence was 1007 Overlook Road, Berkeley.

Eugene Crilly, retired after 20 years in the USDA at Upper Darby passed away suddenly January 9, 1961. His residence was 205 East Manoa Road, Havertown, Pennsylvania.

Samuel D. Beichler, 3261 Peachtree Road, Atlanta, Georgia, passed away February 10, 1961, after several weeks illness. A veteran of 31 years with the U. S. Forest Service he was head of Cooperative Forest Fire Protection in the Southern Region at the time of his death.

Arthur B. Beaumont, retired, died following surgery on Febraury 9, 1961. Until retirement he was State conservationist in Massachusetts and resided at 285 Amity St., Amherst.

Newman I. Lyle, Sheldon, Iowa. Chairman of the Iowa Association of Soil Conservation Districts, Mr. Lyle died suddenly of a heart attack immediately after a session of the Board of Directors on November 1, 1960.

Now . . . A Proven Way to Stabilize Critical Waterways

New S.C.S. Development Holds Soil in Place Until Vegetation Takes Over

By R. V. D. Broach
Soil Erosion Control Specialist
Ludlow Textile Products

Now you can put an end to seed and soil washouts by protecting waterway channels with Soil Saver — a heavy jute mesh that prevents erosion until grass or other vegetation is firmly established.

Soil Saver offers many advantages that make it the most practical aid yet developed for the establishment of turf in critical waterways.

Excellent Mulch

Soil Saver comes in easy-to-handle rolls, 50-and 75-yards long and four feet wide, with openings about 1" square. Pressed into the soil it provides over 3000 erosion "check-dams" per yard. Soil Saver's heavy jute strands provide an excellent uniform mulch, and add more than two tons of organic matter per acre. Because of its heavy open mesh construction, Soil Saver cannot be lifted by wind, water, or growing grass.

If you have seeded critical waterways, diversion terraces, spillways, drainage ditches, dikes or dams, again and again, only to see your top soil washed away by heavy rains, you can now seed these areas with complete confidence that the job will be final and effective.

Outstanding Results

Soil Saver has been thoroughly tested by soil conservation groups for the past two years. It has made successful plantings possible on critical bankings and waterways where other erosion deterrents had failed. Many agronomists are agreed that seeding or sprigging with Soil Saver is the most practical method yet found for establishing vegetation in areas subjected to concentrated water flow. Now, because both terraces and outlets can be constructed *at the same time*, there is no need to temporarily divert water.

Once Soil Saver has been laid, there's nothing to do but wait for the grass to take hold. No maintenance is required. Soil Saver conforms to every accepted agronomic practice.

Send coupon today for free Soil Saver sample and complete installation directions.

Despite several attempts to grow erosion-resistant grasses, repeated washouts turned this Maryland farm waterway into a series of deep gullies.

After regrading and shaping, two widths of Soil Saver were laid to hold soil in place. Soil Saver kept heavy rain from washing out the channel before vegetation was established.

The same waterway is now completely stabilized with deep-rooted vegetation. By the time grasses take hold, Soil Saver has decomposed adding valuable humus to the soil. (S.C.S. Photos)

Ludlow

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NEEDHAM HEIGHTS 94, MASS.

Please send me free Soil Saver sample and installation directions.
My particular problem is:.....

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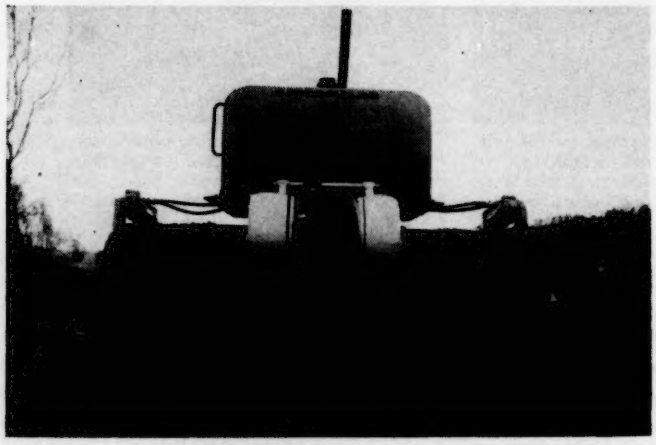
Name.....*Title*.....

Route.....*Box*.....

Town.....

State.....

Cat D4 Tractor with wide shoes conquers mud



This is Gene Patten's D4 equipped with 28" shoes, winch and dozer.

Gene Patten, Cummings, Ga., contracted to improve 5½ miles of channel on the Rooty Creek Watershed near Eatonville. His contract specified a 7′ deep finished channel, 20′ across the bottom with 1:1 slopes. A 1¼ cu. yd. dragline cut the channel, but left a high, muddy spoil bank. Before the job could be completed and accepted by the government, the spoil bank had to be cut down to a maximum height of 3′. If a standard tractor were used, the mud would have to dry for months—otherwise the machine would "bury" itself in the soft Georgia mud.

This was the problem: Mr. Patten didn't want to have to wait for months to finish the job and get his money.

He discussed this problem with his Caterpillar Dealer who studied the application and then recommended the new 52 DBHP Cat D4c

Tractor with special 28" shoes. It proved to have ample flotation to stay on top—plenty of power for efficient earthmoving. The job was successfully completed on schedule.

This type of cooperation between owners and Cat Dealers is an important "bonus" Caterpillar owners can expect to receive.

The 52 HP D4c breathes clean air through a dry-type air cleaner. Controls include a forward-reverse lever. It has 5 forward and 4 reverse speeds. The fuel tank holds 42 gallons of No. 2 furnace oil, enough for a good day's work. The longer undercarriage and higher clearance (14") and many other years ahead features make the D4c an ideal machine for conservation work.

Need a machine to fit your specific application?

Your Caterpillar Dealer is prepared to provide assistance to solve your special land improvement problems. He has the equipment and "know-how" to back his recommendations. He also has a wide variety of attachments and equipment to adapt Caterpillar-built equipment to your needs.

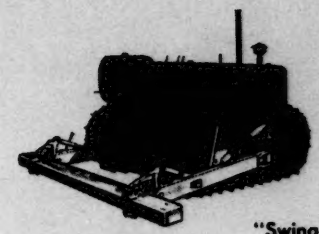
For example, there are more than 30 tools available for the Cat D4 Tractor. A few of them are illustrated at the right.

Almost every job you take has some special problem connected with it. Your Caterpillar Dealer will be glad to help you analyze your needs and select the equipment that will handle the job most efficiently and at lowest cost. He has the conservation experience and equipment to help you make more profits. See him soon!

Caterpillar Tractor Co., General Offices, Peoria, Illinois, U.S.A.

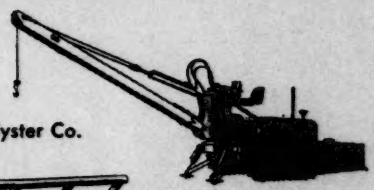
HAVE YOUR DEALER SHOW YOU HOW THESE ATTACHMENTS—AND MANY MORE —CAN ADAPT THE D4c TO HANDLE MORE SOIL AND WATER CONSERVATION JOBS.

Tool Bar Loader built by Balderson, Inc.

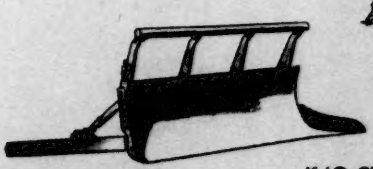


"Swing-Around" Tool Bar for use with ditchers, furrowers, cultivators, bulldozers, ridgers.

Root Rake built by Fleco, Inc.



Crane built by Hyster Co.



K/G Clearing Blade manufactured by Rome Plow Co.

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- ☐ "The profit side of your ledger"
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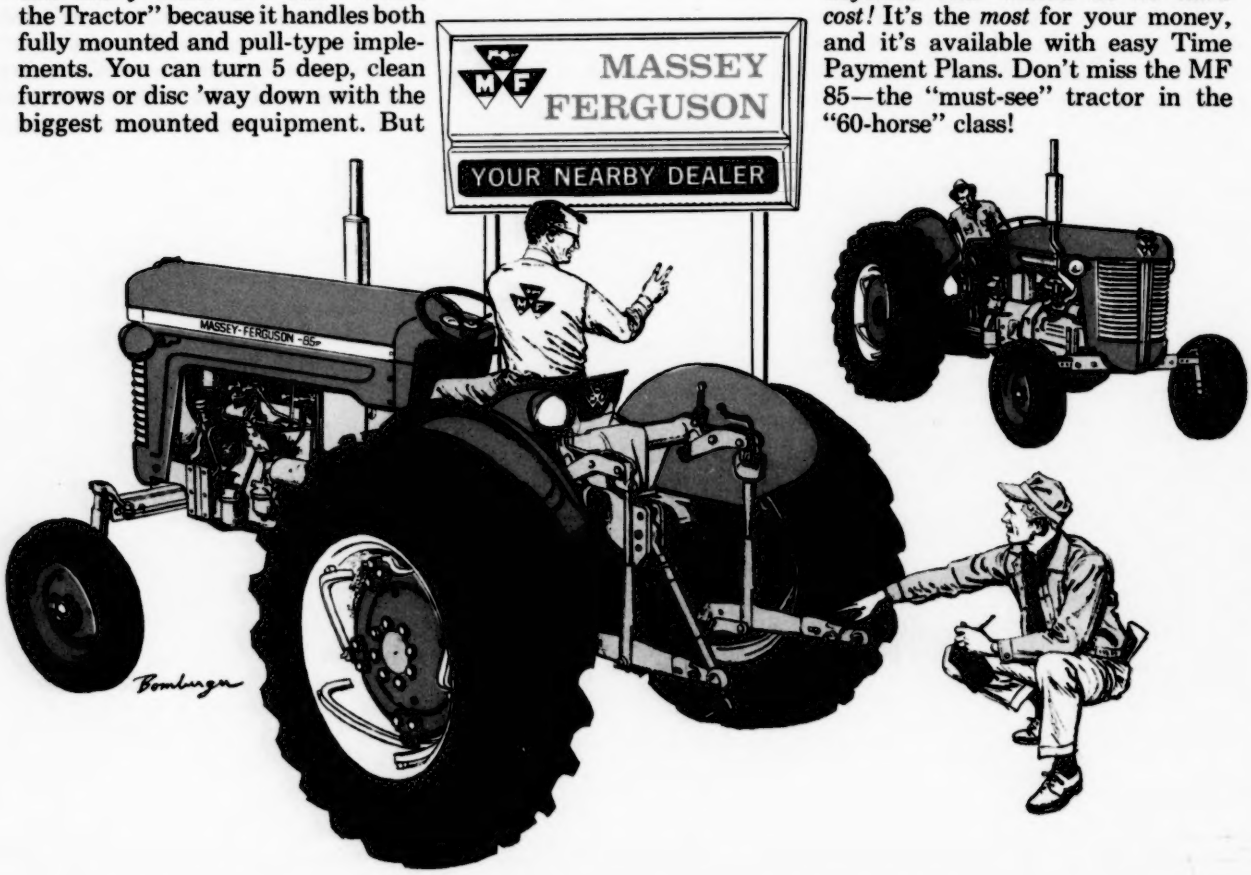
HERE'S THE BRUTE THAT'S TWICE THE TRACTOR

Why "Twice the Tractor"? Because only the Massey-Ferguson 85 gives you: First, the easy-handling, precise work-control of the genuine Ferguson System. And second, the manpower-saving big-job capacity of full 5-plow power! Like all Ferguson System tractors, the big "85" reacts fast and sure to changes in the soil, transfers weight when the going gets tough, and adjusts to light and heavy work. It's also "Twice the Tractor" because it handles both fully mounted and pull-type implements. You can turn 5 deep, clean furrows or disc 'way down with the biggest mounted equipment. But the MF 85 doesn't obsolete your present pull-type tools. With its heavy swinging drawbar and up to 3 remote cylinders, it tackles any pull-type job like a natural-born lugger—5-plow strong! Best of all, in diesel, gas or LP, the big "85" is the lowest priced fully equipped 5-plow tractor you can buy! It comes with power steering, adjustable front axle, engine and ground PTO, and power-adjusted rear wheels at *no extra cost!* It's the *most* for your money, and it's available with easy Time Payment Plans. Don't miss the MF 85—the "must-see" tractor in the "60-horse" class!



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